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The Detroit & Mackinaw road will soon order freight cars.

The Lima Northern road in Ohio will soon contract for 12 engines.

The Toledo & Ohio Central Railroad is in the market for freight cars.

The Southern Railway will locate repair shops at Salisbury, North Carolina.

The Lehigh Valley Railroad has issued specifications for and invited bids on 2,000 coal cars.

The Delaware, Lackawanna & Western has ordered ten standard coaches from the Pullman Company.

The Ohio River road of West Virginia will shortly give out contracts for building four new passenger coaches.

The Chattanooga Southern road will immediately order 50 cars to be ready for delivery during April.

The Canadian Pacific is said to have issued specifications recently for building a number of new engines.

The Seattle, Lake Shore & Eastern road will have 120 cars built at the shops of the Oregen Improvement Co.

The Baldwin Locomotive Works has recently received orders for locomotives for two South American railways.

The Mexican National Railway has placed an order for 10 locomotives with the Rhode Island Locomotive Works.

The Wabash Railroad has placed an order for 500 box cars with the Madison Car Company. The order may be increased to 1,000.

The Choctaw, Oklahoma & Gulf Railroad will build shops at Shawnee, O. T., the citizens of that place having contributed $30,000.

The Chicago Great Western has placed orders for six coaches and two combination cars, each 55 ft. long, with the Pullman Company.

According to the *Locomotive* the number of boiler explosions in the United States during 1895 was 355, in which 374 persons were killed and 519 injured.

The Pennsylvania Railroad has placed an order for 300 coal cars with the Ohio Falls Car Manufacturing Company and 100 with the Mount Vernon Car Company.

The Wheeling and Lake Erie has placed an order for 500 cars with the United States Car Co., and 300 with the Madison Car Co. The order was erroneously reported last month as going to another concern.

The bridge across the Missouri River at Jefferson City, Mo., is practically complete, and it is said the Chicago & Alton and the Missouri, Kansas & Texas will both build short connections that will enable them to use it.

The barbette armor plates recently finished by the Carnegie Steel Co., for the U. S. battleship *Iowa* are so heavy as to require a separate car for the transportation of each plate. The weight of each piece of armor is about 48 ons.

The receivers of the Baltimore & Ohio Railroad have issued an order placing all of the shops on 10 instead of 8 hours time. This order affects about 4,500 men. It will enable the company to improve the condition of its rolling stock.

The Calumet & Blue Island Railway has given an order for 300 cars to the Haskell & Barker Car Company. The cars will have Fox trucks, Westinghouse brakes, Tower couplers, Griffin wheels, Damascus bronze bearings and Chicago roofs.

The Philadelphia & Reading Railroad contracted last month for 1,000 King hopper gondola cars, the order being equally divided between the Union Car Works and the Lebanon Manufacturing Company. The road contemplates ordering 1,500 more cars.

The Buffalo & St. Mary's River Railroad has ordered two 20 by 26-inch consolidation engines from the Brooks Locomotive Works. The same company has received an order for two 10-wheeled passenger engines and one mastodon freight engine, with 21 by 26-inch cylinders, for the Adirondack & St. Lawrence.

The East & West Railway of Alabama, has placed an order for 50 box and coal cars with the United States Car Company. The cars will be built at the Anniston shops. The same car company has contracted to rebuild 250 stock cars for the American Live Stock Transportation Company at its Hegewisch shops.

On March 11 the boiler of engine No. 4 on the Delaware, Susquehanna & Schuylkill Railroad blew up near Gum Run, killing four men and badly injuring a fifth. The engine was hauling a train of empties and was in motion at the time of the explosion. The boiler was nearly new and was supposed to be perfectly sound. The exact cause of the accident is not known.

The Seaboard Air Line has ordered several engines from the Richmond Locomotive Works. It is now in the market for 15 heavy freight engines. It will build 300 box cars immediately. Half of these cars to be built at the company's shops at Portsmouth, Va., and the remaining 150 to be contracted for. Later on in the year a further order for 1,000 cars may be given out by the company.

The Northwestern Elevated Railroad, the fourth elevated line in Chicago, has one mile of four track superstructure completed and the steel for a large part of the remainder of the road is on the ground. It is expected that the work of erecting it will proceed at the rate of a block per day, and that the line will be completed by January, 1897. The construction company has thus far spent $3,591,528.

The citizens of Tyler, Texas, have subscribed $10,000 toward a fund of $12,000, which, if raised, will be applied to the purchase of 40 acres of land on which the St. Louis, Southwestern and Tyler Southwestern Railways will extend their yard and shop facilities, they agreeing, in consideration of the contribution of $12,000 by the city of Tyler, to spend $40,000 in the extension and enlargement of their shops.

The Baldwin Locomotive Works and the Westinghouse Electric and Manufacturing Company have completed a 200 horse power electric mine locomotive for the Crozer Coal & Coke Company, to be used in the mines at Elkhorn, W. Va. This locomotive is from entirely new designs, and has features that it is expected will make it attractive to mine owners. All of the parts are carefully fitted together and are made of the best material. The weight of the locomotive is about 42,000 pounds.

It is stated, on apparently good authority, that upon the completion of the coast line to Los Angeles, the Southern Pacific will make it a portion of the main line between San Francisco and New Orleans, and will then build large shops just outside of the city and on the same side of the bay. The Oakland shops will then be moved to the new site. The new shops will be very large, perhaps rivaling those of Sacramento. It is not the purpose however, to lessen the importance of the latter plant, but rather to put all of the increased shop capacity required into the new and modern plant.

The largest vessel ever built on the great lakes was launched last month, at the shipyards of the Globe Iron Works, Cleveland. The new steamer is being constructed for the Mutual Transportation Company of that city. Its measurements are: Length over all, 432 feet, 48-foot beam and 28-foot depth. Its net tonnage on an 18-foot draught is 6,700 tons of ore or 200,000 bushels of wheat. With a 14-foot draught it will carry 4,500 tons of ore. It was built in anticipation of a 20-foot channel. The engines are of the inverted cyclinder triple expansion type, with cylinders 23, 39 and 63 by 42 inches. She will have four Scotch boilers 11½ feet in diameter by 10 ft. in length.

The Concord & Montreal Railroad will build new shops at Concord, N. H., at a cost of $300,000. The ground occupied will consist of 28 acres. Five acres will be covered with buildings, which will extend along the main track for about 4,000 feet. The plans include boiler and erecting shops, 410 by 70 feet; two machine shops, 305 by 305 feet; blacksmith shop, 60 by 150 feet; storehouse and office building, 150 by 40 feet; lumber shed, 300 by 400 feet; dry kiln, 75 by 25 feet; wood-working shop, 300 by 60 feet; boiler and engine house, 85 by 60 feet; pattern, cabinet and tin shop, 200 by 40 feet; passenger repair shop, 163 by 170 feet; freight repair shop, 162 by 170 feet, and a paint shop, 238 by 50 feet.

The annual report of the Illinois Steel Company for the year 1895 illustrates the improved condition of the iron and steel business, particularly when compared with the reports of the same company in 1893 and 1894. For the year 1893 there was a deficit of $349,472, in 1894 the earnings were only $30,607, but in 1895 the profits were sufficient to warrant the announcement of a quarterly dividend of 1¼ per cent. payable April 1, of this year. The following comparative statement for the three years is striking:

	1893.	1894	1895.
Tons raw material received.	1,283,428	2,339,370	4,355,243
Tons finished product shipped	422,784	503,446	875,698
Wages and salaries paid	$3,230,885.63	$3,071,391.95	$6,533,795.84
Average number of men employed daily	4,264	5,069	10,382

The gratifying increase in men employed and materials handled is still increasing and with about 12,000 men now on the rolls the prospects are that the company can keep them all employed on full time throughout the present year.

The government of Peru has granted a concession to an American citizen, Cuthbert B. Jones, and his associates, for the construction of a railway from the coast to the district of Hualgayoc, where coal mines of great value are reported to exist. Exclusive privileges are granted for 20 years after the completion of the line, which is to be constructed in five years. A grant is made of one kilometer of public land on each side, and contiguous to the track, for every kilometer of railway, and where there is no public land so situated 200 hectares per kilometer will be located elsewhere. Mr. Jones says that some 40 coal mines in the Hualgayoc district are owned by himself and associates, which it is their chief purpose to reach with their railroads, with the view of supplying the vast demand for coal on the Pacific coast, which is now met with coals transported from remote countries. The main trunk line from the coast to Hualgayoc will have a length of about 120 miles, to which it is designed to add a branch to Chota, 18 miles, another to Cajamarca of 35 miles. It is stated that the route presents no engineering difficulties. English bituminous coal was recently sold at Callao at $15.50 (gold) per ton.

A bridge on the line of the Union Pacific at Snake River, 14 miles west of Omaha, was recently erected in a remarkably short time. According to the *Engineering Record* the bridge gang, under the superintendence of Mr. E. F. Terry, now of the Terry & Trench Construction Company, of New York, arrived at the bridge site on the evening of Jan. 24. Work was immediately begun on the traveler and falsework for the three west spans, each of 217 feet center to center of end piers. The three spans were erected, floor system in, and ties and guard rails finished on Feb. 8, making a total of 12 working days in which the entire work was done of putting in falsework, removing the old Howe truss spans, and erecting 660 feet of new bridge. The spans are of the design known as the Pegram truss, which is patented by Mr. Geo. H. Pegram, Chief Engineer of the Union Pacific system. The last span was erected in five hours and 20 minutes. The work comprised in the erection means taking the iron from the yard, raising the trusses, and driving all pins, but does not include putting in the floor system. The floor system was changed in this span in four hours. On this work there were directly employed 70 men, and on the traveler there were 28 men and one six-spool hoisting engine. Mr. J. C. O'Melvey is division engineer.

On March 9 President Roberts, of the Pennsylvania Railroad, and a large number of officials and several invited guests, inspected the company's new bridge over the Delaware, which crosses the river at a point about five and one-half miles above the Market street ferry in Philadelphia. This bridge has been constructed to avoid the ferry over the river at Philadelphia, heretofore used for the transportation of both passengers and freight arriving at that city and destined for New Jersey points. The bridge comprises three Pratt truss spans each 540 feet long, and one draw span 330 feet long, making the total length of the bridge proper 1,950 feet. On the Pennsylvania side there is a steel trestle approach 2,200 feet long, and on the New Jersey side one 320 feet long, so that the total length of the metallic structure is 4,470 feet. There is also some wooden trestle work which is to be filled in as soon as possible. The bridge is 50 feet above high water. Besides the great length of the individual spans and the whole structure the work is remarkable for the dispatch with which it was executed. Ground was broken March 13, 1895, and the bridge was inspected March 9, 1896. At that time one track only was laid, and work was progressing on the second one. The great bridge was thus completed in almost exactly one year. It has cost over one million dollars. As soon as traffic arrangements can be completed many of the passenger trains from Atlantic City, Cape May and other New Jersey points will enter Broad street station instead of Camden, thus giving travelers from out-of-town points and the West a direct route to the seashore, besides being a convenience to many people in New Jersey doing business in Philadelphia.

Communications.

Large versus Small Grates.

Editor American Engineer, Car Builder and Railroad Journal:

Referring to your discussion of the relative merits of large and small locomotive grate surfaces, the most usual type of passenger engine, I believe, has a firebox limited to about 2 feet 10 inches wide by the frame, and is, say, 6 feet long, giving 17 feet of grate. If it were possible to widen the firebox without interfering with its other dimensions a great economy in fuel ought to be effected. However, to get more width it is necessary to place the firebox on top of the frames. Outside of mechanical considerations, the effect of this is to put the grate near the level of the door; cold air can rush straight for the tubes, the distances the gases have to pass through in reaching the tubes is lessened, and in addition no brick arch is admissible. In spite of these facts, there is probably a substantial saving to be had by increasing the grate surface in this manner when consumption is over 150 pounds of coal per foot per hour. This refers to a first-class coal, consisting almost entirely of lumps.

The following figures are instructive. Test No. 1 is the evaporation of a certain coal under a stationary boiler where the consumption per square foot of grate was low. The other figures are taken from tests of the same coal made on a locomotive at different times on the same run, but hauling heavier trains when the last test was made.

	Test No. 1.	No. 2.	No. 3.	No. 4.
Pounds of coal per hour per square foot of grate	....	82.00	87.1	140.
Equivalent evaporation from and at 212 degrees Fahr.....	6.9 lbs.	6.32 lbs.	6.41 lbs.	5.50 lbs.

The engine used was an 18 inch by 24 inch and had 16.87 feet of grate surface. The figures show a decided drop in the evaporation when the higher consumption of 140 pounds of coal was reached. This was not a superior quality of coal, as is evident by the figures, and it had a large proportion of slack or fine coal.

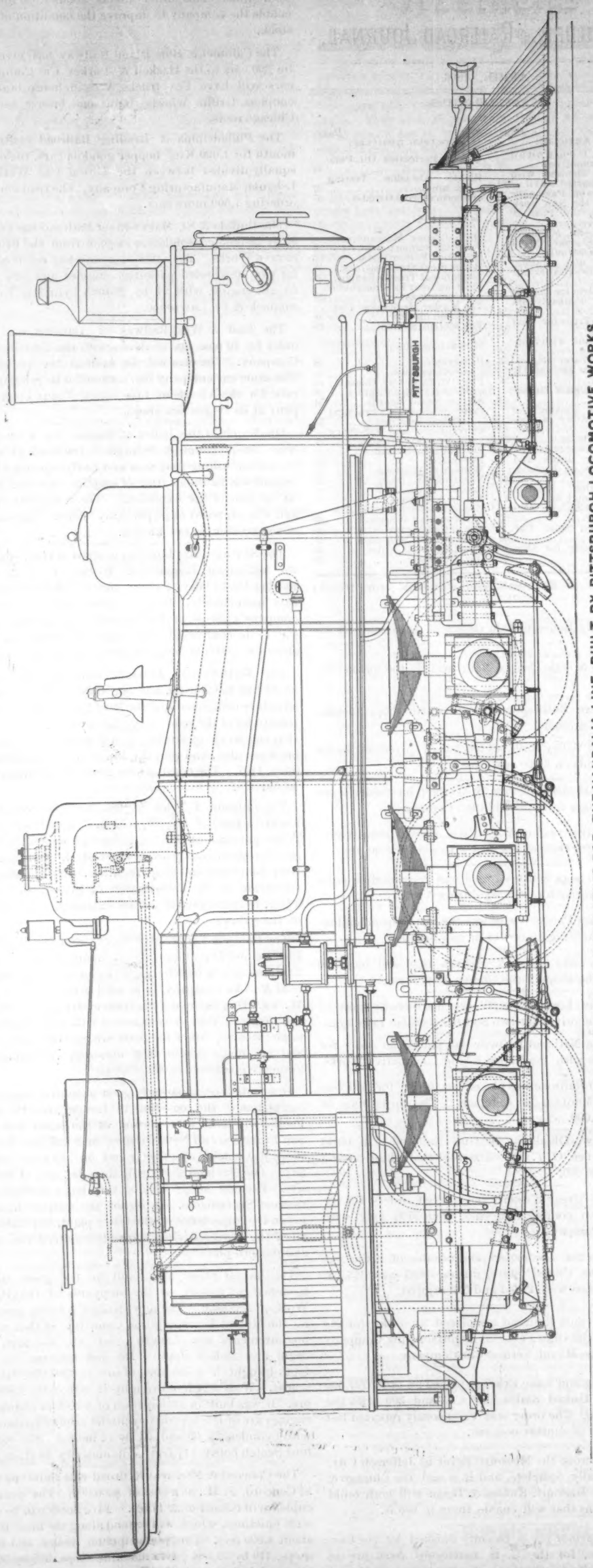
To take a more striking case. Referring to comparative tests of two compound and one simple engine. One compound and the simple engine had about 30 feet of grate, the other compound engine had a deep firebox between the frames of only about 16½ feet of surface. The two engines with large fireboxes give evaporations ranging from 7.87 to 8.05, with consumption of about 60 pounds of coal per square foot of grate. With 114 pounds consumption the small firebox engine gave an evaporation of 6.59 pounds of water. With 130 pounds consumption it gave only an evaporation of 6.1.

All of the tests referred to were averages of from four to six round trips over the same route and were made with care. I. H. Scott.

[Our correspondent's data and deductions, it seems to us, are hardly conclusive with reference to the relative merits of large and small fire grates. He does not give the amount of heating surface in the different boilers tested. Probably the difference in the results which he reports is due more to the difference in the ratio of heating surface to the rate of cumbustion per square foot of grate per hour than to the difference in the size of the grates. A locomotive with 18 by 24 inch cylinders would or should have about 1,600 square feet of heating surface. When it is burning coal at the rate of 82 pounds per square foot of grate per hour the ratio of heating surface per pound of coal burned is about 20:1; when burning 140 pounds per hour the ratio is less than 12:1. More than 40 years ago D. K. Clark showed that the greater the amount of heating surface in a locomotive boiler in proportion to the work done the greater the economy, and he also indicated that the smaller the grate for a given rate of combustion—provided the coal could be burned—the more economical the engine would be. If, instead of experimenting with different rates of combustion our correspondent had taken an engine with a large grate and had made his tests with different rates of combustion with the whole grate open; then if he had covered part of it, say a fifth, with fire-brick and repeated his tests, and thus successfully covered two-fifths, three-fifths and four-fifths, each time repeating the tests with different rates of coal consumption, he would then have had the same heating surface all the time and he would have been able to compare the economy of different rates of combustion with varying proportions of grate. Such an experiment would be well worth trying, and probably the information thus revealed would be worth many times the cost of making the tests.—Editor American Engineer.]

Ten-Wheeled Compound Freight Locomotive for the Vandalia Line.—Built by the Pittsburg Locomotive Works.

The accompanying engraving is a side elevation of one of the ten-wheeled compound freight engines which the Pittsburg Locomotive Works recently built for the Vandalia Line for use on its Terre Haute and Peoria Division. The engine has the usual features of the Pittsburg system of compounding, which have already been described in these columns. One feature of this system is the independent exhaust from the high-pressure cylinder and the consequent ability to work the engine simple at slow speeds with greatly increased tractive power. This is an advantage that is being appreciated, particularly on divisions of roads having heavy grades, as it permits the engine to take a heavier load over the limiting grade of the



TEN-WHEELED COMPOUND FREIGHT LOCOMOTIVE FOR THE VANDALIA LINE—BUILT BY PITTSBURGH LOCOMOTIVE WORKS.

division, a load which usually can be easily handled on the remainder of the division.

The engine has an extended wagon-top boiler, with a firebox between the frames, and the crown sheet supported by radial stays. The following are the leading particulars of the engine:

Fuel	Bituminous coal.
Gage of track	4 ft. 9 in.
Total weight of engine in working order	127,000 lbs.
Total weight on driving wheels	101,000 lbs.
Driving wheels base of engine	11 ft. 0 in.
Total " " " " "	21 ft. 8 in.
" " " " and tender	49 ft. 9½ in.
Height from rail to top of stack	14 ft. 7½ in.
Cylinders, high pressure, diameter and stroke	19 in. × 26 in.
" Low " " " "	29 in. × 26 in.
Slide valves	Balanced.
Piston rods	Steel, 3½ in. diam.
Type of boiler	Extended wagon top.
Diameter of boiler at smallest ring	60 in.
" " " " back head	69 in.
Crown sheet supported by radial stays.	
Stay bolts, 1 in., hollow stay bolts, spaced 4 in. from center to center	
Number of tubes	256.
Diameter of tubes	2 in.
Length of tubes over tube sheets	12 ft. 5 in.
" " firebox ins de	108 ft.
Width " "	32⅝ in.
Working pressure	180 lbs.
Kind of grates	Cast iron, rocking
Heating surface in tubes	1653.0 sq. ft.
" " firebox	152.0 sq. ft.
Total heating surface	1805.0 sq. ft.
Grate area	24.0 sq. ft.
Diameter of driving wheels outside of tire	68 in.
" and length of journals	8 in. × 9 in.
" of truck wheels	28 in.
" and length of journals	5 in. × 10 in.
" of tender wheels	33 in.
Type of tank	Level top.
Water capacity	4,000 U. S. gallons.
Fuel capacity	300 cu. ft.
Weight of tender with fuel and water	78,700 lbs.
Type of brakes	Westinghouse American Automatic.

Piece Work in Car Shops.*

G. L. POTTER.

The manufacturing and repairing of the parts of locomotives under the piece-work system had been practiced a number of years before the system was applied to car work, especially to the repairing of cars. This was due probably to the fact that the amount of money expended on locomotive work is so great per unit; that is, per engine built or repaired, and the labor such a large percentage of the total cost; in new work being about 45 per cent. and in repair work from 65 to 70 per cent., while the cost of labor in building new cars is only from 12 to 15 per cent. of the total cost, and in repairs from 45 to 50 per cent. It is also due to the fact that, on account of the much longer time required to perform the different operations on locomotive than on car work, it is much easier to determine the prices that should be paid, and with much less danger of error.

This trouble in determining theprices to be paid is not so great in building new as in repairing old cars. In new work it is customary in some cases to place prices on the body complete with all the trimmings; *i. e.*, doors, grain doors, air-brakes, etc., applied; in other cases the work is divided up and given out to different gangs of men, one gang constructing the foundation, another laying the floor, another putting up the upper structure, another putting on the sheating, another the roof, etc., so that it requires from one half to a day and a half in the first case, and an hour to five hours in the second, to complete the different operations; consequently the amount of time that should be required is comparatively easy to determine. This is also the case in manufacturing the parts for new work. While each piece can be manufactured in a comparatively short time, they are usually gotten out in large quantities, so that the time required to produce each piece is readily determined.

In repair work the conditions are different. Different cars will require different parts to be repaired, so that it is necessary to establish a price for removing and replacing and repairing each part. The difference in time required to remove the corresponding parts on different cars (even though they be of the same design), and the difference in the time required by different men to perform the same work, and the getting out of the parts in small numbers, are the main difficulties encountered in arriving at prices that are fair to both employer and employee. This can be accomplished only by thorough and careful investigation, extending over considerable time and averaging as many performances of the different operations as possible. When the work has been carried through to a successful issue, the results will well repay for the labor expended.

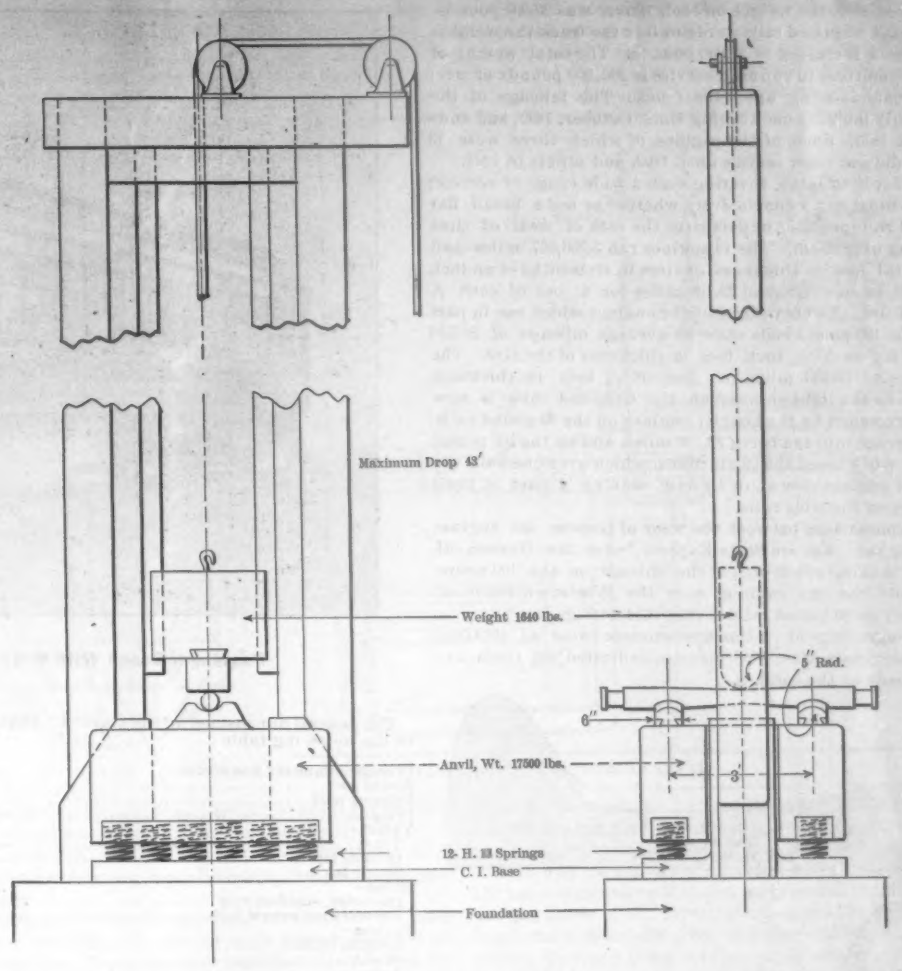
The benefits of the piece work system accrue not only to the employer, but also to the employee; to the former in that he pays for the work performed only what it has been found to be worth, can more easily locate and weed out the incompetent workman, and, with given facilities, will materially increase the output of the plant; to the latter in that he is paid for what he actually does and by increased exertion can increase his earnings, and the more competent workman is enabled to reap the benefits of his greater earning capacity.

There is probably more supervision required under the piece work than under the day work system, in the first place to see that only such parts that actually require it are repaired. There is a great tendency on the part of workmen to renew more parts than are actually necessary, especially if by doing so the earnings can be increased. To provide against this it is customary to have the car thoroughly examined before being taken into the shop, by a competent inspector, who notes on a blank the work to be done, and only such work as is so noted is allowed to be done without permission of the foreman in charge. In the second place the cars should be carefully inspected after completion, to see that all the work called for on the blank has been done and done in a proper manner, the inspector checking the items called for on the blank upon which the parts to be repaired have been entered against the parts repaired on the car. In the third place, there is danger of material being wasted by unscrupulous workmen, especially if parts can be removed more quickly and easily by destroying them. This is particularly the case in truck work, where it is easier to break the bolt off than to take off the nuts.

In starting the piece-work system in a railroad shop, the first impression that is usually formed in the minds of the workmen is that it is a scheme to reduce wages. It is necessary, therefore, to successfully establish a system, to disabuse their minds of this idea and to have them feel that the benefits will be mutual. Failures to introduce the system successfully, where it has been undertaken, can, I think, be traced in the majority of cases to unfair dealings on the part of those in charge, by reducing the prices when it was found that by extra or unusual exertions the workmen were enabled to materially increase their earnings, thus discouraging them and causing them to look upon the scheme with suspicion.

When the piece-work system has been established on a fair and equitable basis, it will be found that the cost of the output will be very much reduced, the workmen will be enabled to increase their earnings, and there will be much less dissatisfaction among them, and a great stride in the solution of the labor problem will have been made.

* Read before the Western Railway Club in February, 1896.



Drop Testing Machine with Spring Supported Anvil—Pennsylvania Railroad.

A Spring-Supported Anvil for Drop-Testing Machines.

In drop testing machines the effect of a weight falling from a specified height is considerably modified by the weight of the anvil and the character of the foundations under it. So greatly does this influence the results obtained that couplers and other articles of manufacture which have met all tests satisfactorily under one drop have been known to fail under others having more substantial anvils or foundations All axle or coupler drop-testing machines have until recently been constructed with anvil blocks which were not heavy enough to resist withtheir inertia the whole force of the blow, but had to depend more or less upon the foundations under them. The heavier the anvil the less duty the foundations were called upon to perform, but in all cases the latter had to take much of the force of the blow, and they introduced an element of doubt into the results which prevented reliable comparisons between the data obtained on different machines, or upon the same machine at different seasons of the year.

To overcome these difficulties the Pennsylvania Railroad has reconstructed its axle drop at Altoona, putting in an anvil heavy enough to meet the force of all blows with its own inertia, and supporting this anvil on springs. Through the courtesy of Mr. F. D. Casanave we present the accompanying illustration of the drop as it is now arranged. It will be seen that on top of the foundations a cast-iron base is placed that forms a seat for the 12 springs which support the anvil. This anvil is a solid block of cast iron approximately 4 feet by 5 feet by 2 feet, and weighing 17,500 pounds. The axle supports are separate pieces dovetailed into the upper face of the anvil and placed the regulation distance apart of three feet. The springs which support the anvil are each composed of two coils, the outer one being 8 inches in diameter and made from steel 1$\frac{3}{16}$ inches in diameter, while the inner one is 5½ inches in diameter and composed of 1$\frac{1}{16}$-inch steel. The springs are 9½ inches high when light and 5½ inches when solid. Compressed to a height of 7 inches the total supporting power of the 12 springs is 80,000 pounds.

It will be evident that in practice this anvil always presents the same resistance to the action of the drop falling from a given height. This resistance is chiefly made up of the inertia of the mass of iron, weighing 17,500 pounds, and any movement of the anvil that may take place is against the force of the springs which support it. Constant conditions are thus obtained and the rigidity of the anvil is not altered by the freezing of the ground or other changes that are unavoidable. This is an excellent improvement and if others using the drop testing machine to test their outputs or to test materials received would employ the same construction and weight of anvil, the results obtained would always be comparable with the work done on other machines of the same design, something which cannot be said of the drops in use at present.

Wear of Tires on Passenger Engines of the New York Central for the Past Twenty Years.

Comparing the weights upon the drivers a few years ago with those in present use shows an increase in the static or dead load of some 65 per cent., while the increased speed of the trains now produces dynamic effects more than double the static loads, yet by increasing the width of the head of the rails as they were renewed and the higher standard of track maintained, the rate of the wear of tires for the heavier locomotives has not increased, but, on the contrary, decreased. In 1883, on the 65-pound rails, deep and narrow type of heads, drivers carrying 13,360 pounds ran an average of 19,400 miles for a loss of $\frac{1}{16}$ inch in thickness of the tires. This was the second type of 65-pound rails, the first one having been rolled in England and had a wider head.

In 1884 the 5 inch pioneer 80-pound rail was put in service, the head being 2$\frac{11}{16}$ inches wide. Its use was yearly extended, and by 1889 locomotives on the Hudson division made nearly one-half their mileage on the 80-pound rails. Engines then carrying 17,600 pounds per driver ran an average of 19,300 miles per loss of $\frac{1}{16}$ inch in thickness of tire.

In 1891 passenger engines on the Hudson division made their entire mileage on the 80-pound rails, while those on the Mohawk and Western divisions made about three-quarters of theirs on the same class of rails; drivers carrying 20,600 pounds ran an average of 19,400 miles per loss of one-sixteenth inch in thickness of the tire. This refers to the loss by wear and returning for future service.

In 1892 the 100-pound rail, head 3 inches wide, was laid on the the Harlem line, which carries the combined passenger traffic of the three railroads entering and leaving Grand Central Station, New York City. The renewing of the entire line of the New York Central & Hudson River Railroad from Mott Haven Junction to Buffalo and return with 80-pound rail was completed in 1892. In 1894 the 100-pound rail was laid from Spuyten Duyvil to Peekskill, making about one-quarter of the Hudson Division laid with 100-pound rails.

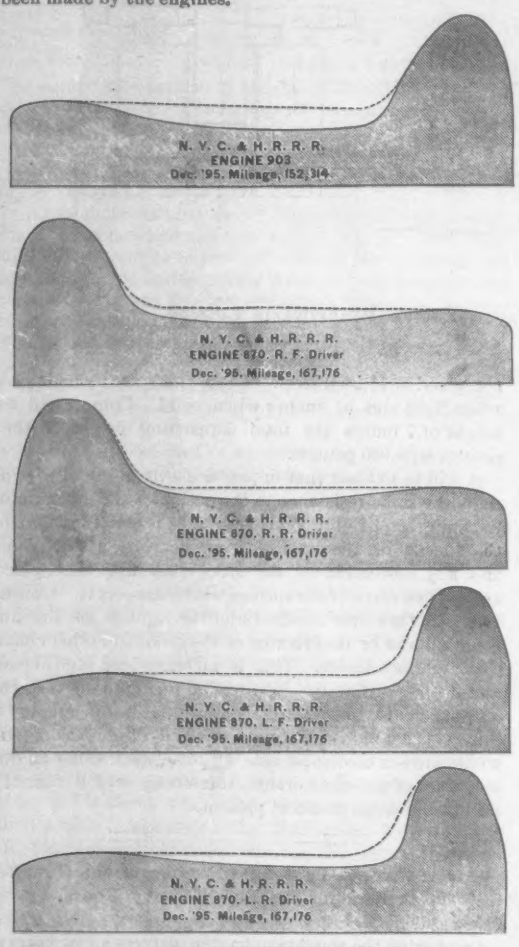
In June, 1895, I asked Mr. William Buchanan, General Superintendent of Motive Power and Rolling Stock, for the mileage of some of the class "I" engines running over the 80 and 100-pound rails. When the class "I" engine was de-

signed in 1889, the weight on each driver was 20,000 pounds, but as the 80-pound rails were put into the track the weights have been increased to 22,000 pounds. The total weight of the locomotives in running service is 200,000 pounds or over 40,000 pounds being upon the truck. The mileage of the tires only includes one turning since October, 1892, and ends March, 1895. Some of the engines, of which there were 43 in all, did not enter service until 1893, and others in 1894.

The list is so large, covering such a wide range of service, that it must show conclusively whether or not a broad flat topped rail increases or decreases the rate of wear of tires running over them. The 43 engines ran 3,706,567 miles and the total loss in thickness of tires in sixteenths of an inch was 160, or an average of 23,166 miles for a loss of each $\frac{1}{16}$ inch of tire. Twenty-three of the engines which ran in part over the 100-pound rails show an average mileage of 29,046 miles for each $\frac{1}{16}$ inch loss in thickness of the tire. The mileage of 19,400 miles per loss of $\frac{1}{16}$ inch in thickness shown by the light engines on the 65-pound rails is now much exceeded by the heavier engines on the 80-pound rails, the average mileage being 23,166 miles, and on the 100 pound rails it will exceed the 29,046 miles, which over one-half the present engines now show by only making a part of their mileage on the wide rails.

The comparison between the wear of tires on the engines running the "Empire State Express," over the Hudson division, making one-fourth of the mileage on the 100-pound rails, and the one running over the Western division exclusively on 80-pound rails is very interesting.

The engravings show the approximate wear as obtained by plaster casts after the mileage indicated on them had been made by the engines.


N. Y. C. & H. R. R. R.
ENGINE 903
Dec. '95. Mileage, 152,314.
N. Y. C. & H. R. R. R.
ENGINE 870. R. F. Driver
Dec. '95. Mileage, 167,176
N. Y. C. & H. R. R. R.
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N. Y. C. & H. R. R. R.
ENGINE 870. L. F. Driver
Dec. '95. Mileage, 167,176
N. Y. C. & H. R. R. R.
ENGINE 870. L. R. Driver
Dec. '95. Mileage, 167,176

Diagrams Showing Wear of Tires on Engines No. 903 and No. 870.

Engine 870 commenced the service for which the wear of the tires is shown May 25, 1894, and completed it Dec. 21, 1895. The engines are double crewed, as is customary with all, and the mileage made per month fluctuated between 8,573 and 9,200. Out of the 575 days the engine was worked 571 days, the 4 idle days being occupied in boiler washing. The total mileage in that period was 167,176 miles. During all this time the fires were not drawn except on the four idle days.

The following table shows the wear of tires with different weights on them and running on various rail sections :

No. of engine.	No. of miles run.	Circumference of drivers in feet.	Pounds of metal lost per 1,000 m. run, 4 drivers.	Rail section on which engines ran.	Weight on each driver.
870	167,176	20.41	0.801	80 and 100-lb.	20,000 to 22,000 lbs.
903	152,314	22.00	1.332	80-lb. rails.	20,000 to 22,000 lbs.
84	56,219	18.06	1.234	English 65-lb. rail	15,000 to 18,000 lbs.
86	73,647	18.06	1.387	" " "	15,000 to 18,000 lbs.
4	73,864	17.28	1.379	" " "	15,000 to 18,000 lbs.

NOTE.—The 100-pound rail has a head 3 inches wide, the 80-pound rail a head 2¼ inches wide, and the English 65-pound rail had a head 2⅝ inches wide.

The loss per yard in circumference of tire, per 1,000,000 tons rolling contract on the rails was as follows :

No. 870.....0.012 lbs.
No. 903.....0.070 lbs.
No. 81.....0.121 lbs.
No. 86.....0.136 lbs.
No. 4.....0.132 lbs.

Passenger Coach With Wide Vestibules.—Lake Shore & Michigan Southern Railway.

The general dimensions of the class "I" engines are given in the following table :

Cylinder, diameter and stroke	19 × 24 in.
Steam port	18 × 1¼ in.
Exhaust port	18 × 2¾ in.
Bridges	1⅛ in. wide.
Valves—	
Travel	5½ in.
Outside lap	1 in.
Inside lap	None.
Boiler—	
Diameter, smallest ring	58 in.
Pressure per square inch	170 lbs.
Firebox—	
Length, outside	105⅛ in.
Width	40⅛ in.
Area	27.3 sq. ft.
Heating surface	150.8 sq. ft.
Flues—	
Number	268
Outside diameter	2 in.
Length between sheets	11 ft. 11 in.
Heating surface	1670. 7sq. ft.
Total heating surface	1821.5 sq. ft.
Weight of engine in working order	120,000 lbs.
Weight on drivers	80,000 lbs.
Weight on trucks	40,000 lbs.
Weight, maximum tender loaded	80,000 lbs.
Tractive force per pound M. E. P.	111.07
Adhesion to tractive force	0.20
Diameter of drivers	78 in.
Driving wheel base	8. ft. 6 in.
Total wheel base of engine	22 ft 9 in.

Engine No. 903 hauled the "Empire State Express" on the western division from April 3, 1894, to Dec. 3, 1895, total mileage 152,314. Of the four tires of engine No. 870, the left front one, was physically the softest and shows the most wear as seen in the accompanying illustrations. Both front drivers show increased wear over the rear ones from crushing the sand when first applied to the rails, and is more noticeable than on the crucible steel tires of the lighter engines of which I took plaster casts many years since. Ross Meehan shoes were applied to the drivers covering the full tread and flange of all drivers for both engines. On No. 870 considerable wear was produced on the outside of the flanges of the left side drivers, which is not included as it was not produced by the rails.

The wear of tires per 1,000,000 tons rolling contact on the rails for the amount of metal lost, as shown by plaster casts, would be influenced by many conditions which need not be considered here, yet the results point to the same general fact that by widening the top of the rail, and giving it a larger top radius, the rate is decreased, notwithstanding an increased weight is carried upon the drivers. The top radius of the pioneer 80-pound rail is 12 inches, with $\frac{5}{16}$ inch corner radii, and for the 80-pound and 100-pound rails, laid in 1892 and since, it is 14 inches, and corner radii of $\frac{5}{16}$ inch. The important point is to secure as large an area of contact between the drivers and the rails as practicable, for the larger the area is the less are the wheel pressures per square inch of contact, and the greater width of metal of both rails and wheels to resist and distribute the tractive force exerted. The tractive force of both 870 and 903 on the rails drawing the same train would be practically alike, and the difference in wear of tires mainly due to the greater average area of contact of 870, running part of its distance on the 100 pound rails, while 903 ran entirely on 80-pound rails. The mileage of either engine is very large, nearly double what is obtained on the narrow-headed rails, as will be seen by a comparison with engines Nos. 84, 86 and 4, which ran on the 65-pound rails. The practical results of introducing the broad-topped stiff rails show a decreased wear of tires, frogs, rails, ties, and expense of minimum maintenance while the speed and train loads have been largely increased. The standard freight train load of the New York Central & Hudson River Railroad, on the 80-pound rails, is 50 loaded 60,000-pound capacity cars, making a gross load of 2,250 tons, forming a train 2,000 feet long, which runs 150 miles in six to eight hours. The train load has more than doubled from the old 65-pound rails.

The broad thin type of head is making rapid progress abroad. Dr. Haarman at his Osnabruck works, Germany, has introduced several sections, while many are being rolled in England for India and Australia. My 80-pound section has recently been rolled in England for two Canadian lines.

While the thin wide head and stiff type of rails is now generally recognized as the most economical form, the pioneer 5-inch 80-pound rail met with decided opposition as being heavier and stiffer than was needed. Its introduction was largely due to the persistent efforts of Mr. J. M. Toucey then General Superintendent but now General Manager of the New York Central & Hudson River Railroad. The rail once in the track made friends and had strong advocates for the value of stiffness in a section was recognized, the principle being utilized by many railroads. It is not weight alone but stiffness as well which gives value to a section. It marked an epoch in railway progress, and while the advantages of a broad head and stiff 5-inch rail have exceeded expectations there are still greater values to be obtained by the use of the broader head and stiffer 100-pound rail.

P. H. DUDLEY,
New York.

Passenger Coach With Wide Vestibules.—Lake Shore and Michigan Southern Railway.

The Lake Shore & Michigan Southern Railway is equipping some of its first-class passenger coaches with wide vestibules, and the first one, which was recently turned out of the Cleveland shops, is illustrated in this issue. As will be noticed, the vestibule extends the full width of the car, and is provided with windows in the ends and doors extending to the bottom of the sheathing on the side. The steps are stationary and are covered with trap doors, which can be opened from the outside as well as the inside of the vestibule. Gates close the opening in the vestibule when this is at the rear end of the train. The vestibule is the Gould pattern with wide buffers.

The car is 52 feet 6 inches long over endsills and 61 feet over couplers, 9 feet wide over side sills and 14 feet 7 inches high over all. End sills and side sills are double and are reinforced by iron plates. The end of the car is strongly built, without windows and the posts are reinforced by iron bars.

The interior finish is mahogany, plainly but neatly carved. The sash is compound, allowing the lower one to be raised high enough so as not to obstruct the view when open. The deck sash is hinged at the end and is glassed with light yellow ondoyant glass.

The car has two saloons, located at diagonally opposite corners and at the ladies end there is a lavatory and water cooler. The car seats 62 people and the seats in the car illustrated are the Hall & Kilburn "walkover," upholstered with seal brown figured plush ; the curtains are the Adams & Westlake "Acme."

The car is lighted by Pintsch gas, supplied by one reservoir, the body of the car having five 4-burner lamps and each vestibule one 2-burner lamp. The heating is by direct steam, two rows of 2-inch pipe on each side of the car being sufficient in the coldest weather.

The trucks have a wheel base of 8 feet, have 42-inch Allen paper wheels and National Hollow brake beams.

The car complete weighs about 68,000 pounds. The illustrations show the exterior of the car painted a dark color, which is the standard color of the Wagner Palace cars. The striping is in gold, plain and neat. This car with another one like it, will run on the South Western Limited between Buffalo and St. Louis.

Ten other cars are to be similarly equipped, but will be painted the standard Lake Shore yellow and will be used in through service between Buffalo and Chicago.

At the Great Northern works at Doncaster, England, there is being constructed what is probably the largest sleeping car in Great Britain. It is 66 feet 8 inches in length, 9 feet in width, and 13 feet 2 in. in height, and so fearful were the officials of its adaptability to the physical conditions of the road, that the completed framework was recently run over the line from Edinburgh to Aberdeen, in order to see whether it could successfully take the curves on the road. The trip was entirely successful, and the carriage was taken back to the shops to be completed, when it will be put into service on the east coast route. The carriage will be finished in a very elaborate manner.

boiler, or three times greater in proportion than Howden's arrangement. There is, however, this advantage: the furnaces are under less pressure than the stoke-hole, and a certain quantity of cold air can be allowed to enter from the stoke-hole below the fire-bars. This sweetens the air in the stoke-hole, as the air that is taken away is replaced by pure air from above, and any leakages about the furnace fronts or casings act in the same way, drawing in air. The temperature of the stoke-hole was only 80 degrees. A certain amount of cold air admitted under the fires does not appear to affect the economy much.

From experiments made at Sheffield, it was discovered that by raising the firebars a few inches at the back (instead of lowering them at the back in the usual way) the bars would allow the fires to be forced very much more severely and would give no trouble when burning over 60 pounds of coal per square foot of grate. Sloping the bars up toward the back has a further advantage, that it is easier to see that the whole of the grate is covered through the firedoor, and there is no chance of the flame being blown in your face. Another advantage the arrangement in this vessel possessed was the control the engineer had of regulating the quantity of heated air admitted above and below the bars, with peep-holes to watch the result while regulating. With bituminous coal all the hot air would be put over the fires and the smoke almost entirely consumed.

The consumption per indicated horse power (on voyage) of which particulars are given, was 1.41 pounds per hour with soft coal (not South Wales coal), which equals .539 I. H. P. per square foot o heating surface, and 17.13 I. H. P. per square foot of bar surface, and 24 2 pounds of coal per square foot of grate, with 3¼-inch W. G. vacuum at fan and chimney, and 1-inch W. G. vacuum at ash-pit.

I should mention that in firing and cleaning fires, the action of opening the door automatically closed off the draught from the furnace and prevented the cold air from rushing in. At Sheffield they think this an unnecessary precaution, and I do not think it is adopted there. They hold the opinion that with suction draught the heat impinging on the ends of the tubes and tube-plates is altogether different to what it is with forced draught. The adherents of suction draught say it sweeps clear of the ends of the tubes and enters in the center, while with forced it impinges on the tube ends. Many other engineers maintain that the action is precisely the same in each case; the draught is due to difference of pressure at the base of the funnel and at the furnace mouth.

From experience at Sheffield they advise the air space at the back of furnace between the bars to be reduced, as the draught is more intense at the back end of grate.

The fans are about double the capacity in the suction arrangement of draught compared with the other arrangements, due to the gases having expanded by the heat, and the gas from the coal burned having to pass through the fans. Although double the capacity, the adherents of suction draught maintain the fans do not require double the power, as the work done is much the same, whether you put the power at either end of the conduits, but the fans, being larger and heavier, have more friction, and are said to require 25 per cent. more power to work them in handling the lighter gases.

E. The Closed Ashpit System is the fourth arrangement mentioned. Although, perhaps, the oldest, this is the least adopted, through the fear of using cold air under a high pressure. The arrangement works very well if properly designed. You can get a very high power from a light boiler, but you must take the precaution not to inject the air directly into the ashpit; only arrange it so that the air is circulating all over the furnace front, and let pressure into the furnace at various parts above and below the bars.

The stoke-hole is quite open in this system, and it has this advantage over all the others, that you have merely to open the ashpit doors and stop the fans in order to work with natural draught. The fans draw from the engine-room or stoke-hole, as desired, and keep the engine-room and stoke-hole more comfortable than with natural draught. You will notice from the table that with this arrangement the power on trial was very high for the weight and heating surface—22.6 I. H. P. per square foot of bar surface and .714 per square foot of heating surface, with 4 inches air pressure at fans and 2 inches at ashpits.

Under ordinary cruising conditions the power was reduced to 13.3 pounds of coal per square foot of bar surface, and .418 I. H. P. per square foot of heating surface. The consumption was 1.56 pounds of Welsh coal per I. H. P. per hour, with 1¾ inches air pressure at fans. This arrangement has also been working satisfactorily for years.

The results given are from a similar arrangement to that so well worked out by Mr. D. J. Dunlop, Port-Glasgow, and published in *Engineering*, March 18, 1892, fitted in the yacht *Mira* which had the exciting race from Cloch round the Cumbraes with the yacht *Hermione*. This was a private tussle—closed ashpit *versus* Howden—and ended in a victory for the closed ashpit by several minutes. Both yachts were designed by the same naval architect.

I annex a sketch of Ellis and Eaves' combination. The other arrangements are so well known that sketches are unnecessary.

The sketch shows the arrangement as adopted for land purposes at Sheffield. For marine work I think it would be advisable to draw the air through outside the tubes, and let the coal gases pass through the tubes; they could then be swept when overhauling in port from outside the heating-box, same as boiler tubes.

In further reference to the table of comparisons annexed, the first two refer to mail steamers kept continually working at full power. They are exactly the same in every respect, except the system of draught employed. These two steamers when working under favorable conditions, the closed stoke-hole made the fastest passages with American coal and the Howden system the quickest with Welsh coal, but latterly the closed stoke-hole is quicker, taking all last season on an average, of six hours per passage. This vessel was not designed to suit Howden draught originally, but the boilers were designed to suit forced draught. The average consumption of average voyages with Welsh and American coal takes 10 per cent. more coal per indicated horse power than mentioned in table. The furnaces with the closed stoke-hole arrangement stood quite as well as with Howden's draught, but the tubes began to leak at combustion chamber end, and her boilers had to be retubed at a much earlier date than with Howden's draught.

Altogether, it is a very creditable result for the Admiralty system where you can afford to carry weight for engines large enough for economical working with a good number of expansions.

The indicated horse power per ton of boilers and machinery is almost as great in these two express vessels on ordinary work as the others on trial. This is where the human element comes in. The indicated horse power per ton of machinery is very nearly alike in the other examples.

The second two refer to swift cargo steamers of the same type.

The fifth column refers to a yacht of 1,500 indicated horse power, showing that a large horse power can be obtained with this arrangement when necessary. With it natural draught can be adopted, and save the decks from the discharge of ashes caused by forced draught.

Generally, I have no doubt that examples might be obtained from any of these systems, showing a greater power obtained from the coal or from the weight, but the examples I have taken are from vessels under or about the same conditions for a fair comparison.

On trial, in the instances mentioned, the closed ashpit arrangement is much superior to all the others in indicated horse power per ton of machinery, and Ellis and Eaves' system shows the most power per square foot of heating surface on voyage. This should be expected, as it is the only one fitted with Serve tubes, but I do not think the full advantage of these tubes has yet been taken in designing boilers. I have advised in boilers now building to reduce the number of tubes. In that way we get larger furnaces, and greater power from the same dimensions of boiler, and depend on the heat absorbing power of the Serve tube to make the heat distributing furnace more effective. The Serve tubes will be worth paying for under these conditions. Howden's arrangement shows the greatest power per square foot of grate both at trial and on voyage, due to using shorter firebars.

From my own experience I know that each of the systems can be made to work very satisfactorily. The furnaces will not give trouble with any of these systems so long as the air is properly admitted, although, naturally, one would be led to suppose that the heated air would do the furnaces less damage.

The most economical arrangements are the heaviest, probably because of the air-heating tubes which are employed in these systems. When the length of voyage is limited it becomes questionable whether the increased economy is worth obtaining when it is necessarily accompanied by increased weight. But in the case of a long voyage the smaller consumption will necessitate less coal to be carried, and so the total weight of boilers and coal will be less than when lighter systems are employed.

The fans themselves are the most important factor of any forced draught system. When the fans are too small they have to be overdriven, and soon come to grief. I have found that a good empirical rule for the capacity of the fan is—

$$\frac{\text{Width at periphery} \times \text{dia.} \times \text{cir., all in feet}}{3}$$

= cub. ft. of air per rev.

Allow for 250 cubic feet of air per pound of coal to allow for leakages, etc. Of course you will require to see that the speed of the fan periphery is suitable for the amount of air pressure to be carried, say—

$$8 \sqrt{68 \times \text{inches water gage air pressure}}$$

= speed of fan tips in feet per second to balance inches water; multiply by 60 and divide by circumference of fan in feet = revolutions of fan per minute for forced draught.

If you leave the proportioning of the fans to the fan-makers they are apt to supply fans which are much too small for the work required, in order to reduce the price.

If the fans are over double the capacity given by this rule they can be depended upon to work in the funnel glass after they have been reduced in temperature by the air-heating tubes.

These air-heating tubes have been the saving of the induced system. When the fans are put direct in the funnel, as originally fitted, it is quite probable that you might find only the stumps of the blades left after the trial when consuming a large amount of coal with small heating surface.

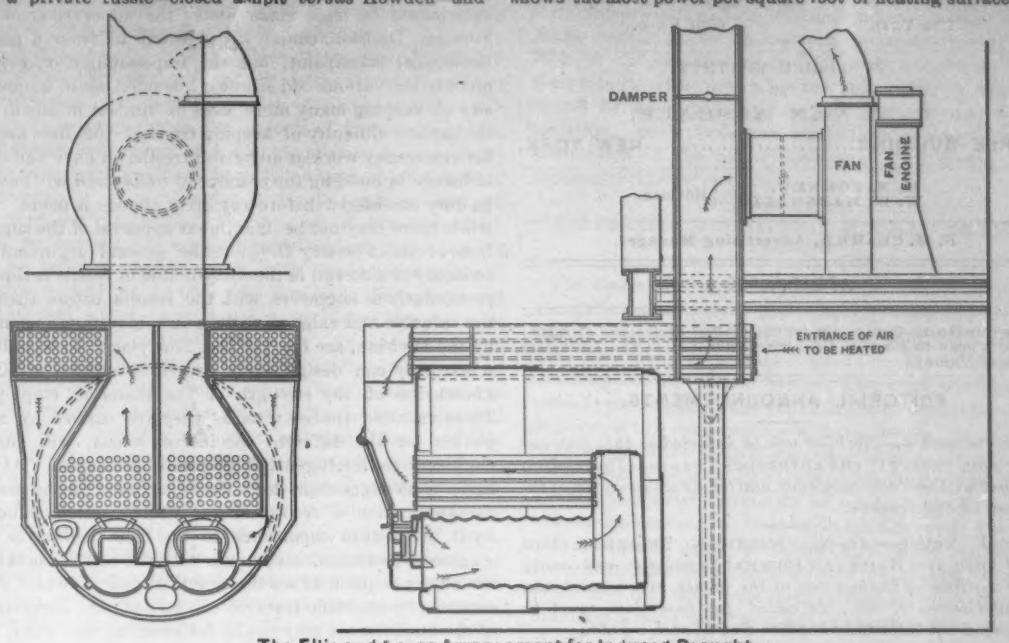
Another decided improvement was that adopted by Messrs. J. & G. Thomson in the vessel from which the particulars are given, namely, in placing the fans on brackets on the casing of the vessel instead of on the hot uptakes, which soon heat up the fan base.

I should mention that all the arrangements mentioned are now fitted with retarders except the natural draught example. This seems to be an important factor in the economy derived from forced draught.

Some owners think it a greater invention than that of the triple-expansion engines, because, fitting it to some of their steamers when the conditions were favorable, the saving was as much as 10 per cent. of coal.

I should mention the consumption of coal per indicated horse power is arrived at by reducing the indicated horse power calculated from the diagrams at the revolutions the the engines were then working, to the power equal to the mean revolutions from the counters on the voyage as the cube of the revolutions and the total coal consumed between ports, according to the American navy practice.

A friend proposed to add the particulars from a good modern ordinary draught steamer to the table for comparison at *F*; this I have done. All the steamers have the same style of feed-heater except *E*, which is not fitted with one.



The Ellis and Eaves Arrangement for Induced Draught.

COMPARISON OF MECHANICAL DRAUGHTS.

	A Closed stoke-hole system.	B Howden's system.	C Howden's system.	D Suction system.	E Closed ashpit system.	F Natural draught system.
Engines and working pressure	Triple, 160 lbs.	Triple, 160 lbs.	Triple, 180 lbs.	Quadruple, 200 lbs.	Triple, 170 lbs.	Triple, 165 lbs.
I. H. P. per square foot of grate—trial			24.13	21.7	22.66	14.73
I. H. P. per square foot of grate—voyage	16 1	18.6	16.96	17.13	13.3	10
I. H. P. per square foot of heating surface—trial			.577	.682	.714	.5
I. H. P. per square foot of heating surface—voyage	.372	.393	.405	.539	.418	.346
I. H. P. per ton of boiler and appurtenances—trial			16.8	14.7	19.6	15.9
I. H. P. per ton of boiler and appurtenances—voyage	13.71	13.71	11 8	11.6	11.51	11
Length of firebars	6 ft.	5 ft. 3 ins.	5 ft. 3 ins.	5 ft. 9 ins.	6 ft.	5 ft. 6 ins.
Pounds coal per square foot of grate—voyage	25.9	28.2	25.3	24.2	20.7	15.4
Pounds coal per I. H. P. at time cards were taken			1.4			
Pounds coal per I. H. P. per hour, mean of voyage	1.6	1.52	1 51	1.41	1.56	1.53
Quality and purpose used for	American, very good; used for propelling machinery only.	Welsh, good; used for propelling machinery only.	Soft coal; used in main boilers for all ship's purposes.	Soft coal; used in main boilers for all ship's purposes.	Welsh; used in main boilers for all ship's purposes.	Soft coal; used in main boilers for all ship's purposes.

(Established 1832.)

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Contributions.—*Articles relating to railway rolling stock construction and management and kindred topics, by those who are practically acquainted with these subjects, are specially desired. Also early notices of official changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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The experience of the New York Central road with extended piston rods for locomotives has been so favorable as to make reasonable the belief that the saving in wear of cylinders and pistons more than compensates for the expense and maintenance of the additional parts. The extended rods have been fitted to quite a number of the heavy 19-inch passenger engines hauling the Empire State and other fast trains, and as these engines come into the shops for general repairs their cylinders have been examined and in a number of cases it was not found necessary to do any work on them, they being sent out untouched for another two years of hard running. Engine No. 870, well known for its regular work on the Empire State Express made 167,176 miles while out of the shop and the wear of the cylinders was less than $\frac{1}{32}$ of an inch. Officials from other roads have been impressed by the record made and it is possible that extended piston rods may be used more extensively on heavy engines in this county and viewed more favorably by railroad men than heretofore. The packing used in the case cited above consists of three cast-iron spring rings.

The use of a heavy anvil supported on springs in connection with a drop-testing machine, as illustrated on another page, is a genuine and truly scientific improvement of a machine that has heretofore been somewhat crude. A drop of 1,640 pounds falling from a given height has a fixed amount of energy stored in it, but the force of the blow given to the object on which it falls depends upon how suddenly its motion is arrested. If neither the object nor the foundation under it yielded in the least the force of the impact would be infinite, but with the smallest "give" the force of impact comes within the domains of the finite, and is rapidly reduced in amount as the yielding of the object increases. For this reason the weight of the anvil and the character of the foundations under it have had the effect of modifying the effect of the drop and making it difficult or impossible to accurately compare the results obtained from different machines or the same machine at different times. But by providing an anvil sufficiently heavy to take care of the force of impact without the aid of the foundations and then interposing springs that effectually prevent these foundations from having any influence whatever, the resistance to the force is made as constant as the force itself, and comparable results are obtained. The value of this improvement will we think be generally recognized.

The suggestions for the economical designing of timber trestle bridges sent out by the Forestry Division of the Department of Agriculture, and published in abstract elsewhere in this issue, will doubtless be read with interest by those concerned in the design and maintenance of such structures. The scaling down of the sizes of timbers at present used to conform to reasonable factors of safety, as determined by tests made under the supervision of the Forestry Division, cannot be objected to from a purely theoretical standpoint, but the impossibility of getting quickly the various odd sizes thus decided upon, the necessity of keeping many more sizes of timber in stock, and the greater difficulty of keeping track of the sizes needed for emergency work at any given trestle, all have had their influence in molding the practice of to-day and will have to be duly considered before any great change is made. But while there may not be unanimous approval of the suggestions of the Forestry Division, the general argument for economy of material in the construction of trestle is timely, particularly as engineers, with the results before them of the valuable and exhaustive tests and investigations made by the Division, are for the first time placed in a position where they can design such structures with an accurate knowledge of the strength of the materials employed. These valuable timber tests, as they are carried to completion for the different species of woods, will enable engineers to intelligently inaugurate economies. At the same time suggestions from the department on the practical application of results of the timber tests conducted by it, are next in importance to the tests themselves, for engineers as a class, in common with the rest of mankind, are none too quick to see the practical uses to which data obtained by scientific research can be put; the suggestions of the Department may not be followed to the letter, but they will certainly be prolific of good, in that they will induce engineers to make a more extensive use of the information than would otherwise be the case.

Before leaving this subject we would call the attention of engineers to the fact that though the tests have thus far cost only $40,000, it is probable Congress, if left to itself, will fail to appropriate the small amount necessary to carry on the work for the fiscal year. If engineers and others will write to the Congressmen of their States urging upon them thevalue of the work and the wisdom of an appropriation, the funds will doubtless be forthcoming.

In specifying the physical qualities of boiler steel it is customary to designate a desired tensile strength and elongation, and to state the limits above and below these figures within which the manufacturer must work if his material is to be accepted. Thus, if the desired strength is 60,000 pounds and the elongation 25 per cent, the specifications would probably be so framed as to accept steel of a strength not less than 55,000 pounds or more than 65,000 pounds per square inch, with an elongation of 25 per cent. or more. Some such latitude is necessary or the specifications would be too rigid and cause needless trouble and expense. But with the knowledge that within certain limits, a reduction in the tensile strength of a given quality of steel permits of greater elongation and an increase in strength has a tendency to reduce the elongation, it is apparent that a manufacturer who furnishes a steel of more than 60,000 pounds strength and 25 per cent. elongation is really producing a better material than called for in the specifications, while if its strength is less than 60,000 pounds without greater elongation, it is inferior. Consequently, if a road wishes to get an equally good steel for all strengths within the limits specified, and yet not demand from the manufacturer more than it is entitled to, it should require a greater elongation in the lower part of the scale of strengths and be content with less elongation in the upper half of the scale. The Pennsylvania Railroad has met this point very nicely in its specifications by requiring that the product of the tensile strength and elongation shall not be less than a certain figure. For shell steel the specifications say: "These plates will be rejected if the test piece shows: 1, A tensile strength of less than 55,000 pounds per square inch; 2, An elongation less than the quotient of 1,400,000 divided by the tensile strength; 3, A tensile strength over 65,000 pounds per square inch; should, however, the elongation be 28 per cent. or over, plates will not be rejected for high strength." For fire-box steel the corresponding clause reads: "These plates will be rejected if the test piece shows: 1, A tensile strength of less than 55,000 pounds per square inch; 2, An elongation less than the quotient of 1,450,000 divided by the tensile strength; 3, A tensile strength over 65,000 pounds per square inch; should however, the elongation be 30 per cent. or over, plates will not be rejected for high strength." From this we see that if the strength of fire-box steel is 55,000 pounds the elongation must be at least 26.4 per cent. if 60,000 pounds, 24.1 per cent., and if 65,000 pounds, 22.3 per cent. This sliding scale of strengths and elongations is a neat way of providing for uniform quality, and is just and equitable to all concerned.

While the details of the various kinds of starting valves for two-cylinder compound locomotives differ considerably, the valves themselves may be generally divided into two classes—those which automically change the engine from simple to compound working and are not under the control of the engineer, and those which are non-automatic in the sense that the engineer can at will operate the engine as a simple one, either at starting or after the train is in motion. In the latter class the proportion of parts and passages is such that no additional power is obtained by working the engine simple except at low speeds. Of late the drift of opinion seems to be in favor of starting gears of this last mentioned kind, and there certainly appears to be some superior advantages in this method of construction. Many divisions of important railroad lines have limiting grades which decide the load which an engine can be assigned, this load of course falling far below what the engine can economically handle on the remainder of the run. If the operating and mechanical departments wish to increase the weight of trains hauled on such divisions in the interest of economy, it becomes necessary to build larger engines or use helpers. Assuming that larger engines are decided upon, these new locomotives, like the old ones, will be greatly underloaded on all but the hills. Now, if a road with such physical characteristics elects to build compound engines for this traffic, it will find that the style of starting gear employed may make some difference in the size of the engine. If the engine cannot be worked simple at the will of the engineer, it must be made powerful enough to take the maximum load over the heaviest grade while working compound; on the other hand if it can be worked simple with increased tractive power on the grade, the cylinders can be somewhat smaller, with the result of making them better adapted for working economically on the level; or to put it another way, with the same size cylinders the engine that can be made to work simple on the heaviest grades will not only take a heavier train over the division, but be better loaded for economy on the level portions of it. A tramp compound engine of the 10-wheeled type sent out by one builder, and tried on many Western roads, was capable of exerting about 18,000 pounds draw bar pull when working compound at slow speeds, but by throwing it into a simple engine the maximum drawbar pull rose to nearly 24,000 pounds, and several times this advantage enabled it to take trains over grades on which it otherwise would have stalled. These considerations have doubtless influenced opinion in favor of this type of starting gear, though it is apparent that the advantage mentioned would be of lesser importance on a practically level road.

THE MASTER MECHANICS' CONVENTION FOR 1896.

With the approach of spring the committee of investigation of this association, which were appointed at the meeting of the previous year, begin to bestir themselves in the preparation of their reports and the collection of data to be submitted to the coming meeting. At most other engineering associations the proceedings or "transactions" consist chiefly of papers written by members on subjects selected by themselves, and concerning which it is assumed they have seme special information which is worth communicating to their fellow-members and the public.

The system which is followed in the Master Mechanics Association and its congener, the Master Car Builders' Association, and has been practised ever since they were organized, is somewhat different from the methods adopted by other analogous associations. At each meeting a committee is appointed to find subjects which it may be thought require investigation, and concerning which interesting and profitable reports might, could, would or should be made. The constitution of the Master Mechanics' Association then provides that "when the committee on subjects has reported, and the association approved of subjects for investigation, the President shall appoint special committees to investigate and report on them, and may authorize and appoint a special committee to investigate and report on any subject which a majority of the members present may approve."

It is a sort of unwritten law of the association, that no member shall refuse to accept such an appointment, and it is usually regarded as a compliment to be placed on a committee of this kind.

This year the technical bill of fare which has been prepared is an unusually inviting one, and the committees appointed, with perhaps the exception of the tail end of No. 10, are of such a character that excellent reports may be expected from them.

To those of us who have been listening to reports read before this association, for a quarter of a century or more, some suggestions naturally occur. We recall the fact that the reports may be roughly though very discinctly divided into two classes—those which bore the audience to which they are read and those which don't. Now it may safely be said that as soon as the boring begins the profit ends, and when the listeners begin to yawn they are no longer instructed. In a report which is intended to be read to an audience as miscellaneous as that which assembles annually at these conventions, the first thing to guard against is overstraining the attention of the hearers. It should be remembered that the attention which the listeners can or will give to a paper, report or address, is very limited and is soon exhausted. Probably, if they were entirely frank, most persons who have for any considerable time been attendants at the meetings of technical societies would admit that most of the papers and reports which are read are

very tiresome. Unfortunately, most people think that what they have written will be, or should be, interesting to others. So inordinate is human conceit and vanity that few of us ever candidly consider whether if some one else had written what we have, and should read it to an audience of which we formed a part, we would be interested, instructed or wearied by it. Now, the other fellow, to whom we read our papers, is just as apt to be bored as we are when he reads his to us, providing neither of them contains food for instruction or overpasses our capacity for consuming and digesting it.

In mechanical construction we always keep in mind the limit of elasticity of the material used before we load or strain it. If we are wise, we will consider the elastic limit of an audience before we impose too great a natural strain on the attention of those who compose it.

There is another reason too why reports prepared for the Master Mechanics' and kindred associations should be limited in length. Their purpose is generally to present the various aspects of the subject, so that it may be intelligently discussed after the report is read. If an audience is tired out by listening to a too lengthy dissertation there will not be sufficient mental power left to carry on a profitable discussion. To call out a good debate of a subject at such meetings, it is therefore of the utmost importance that the report should be brief and terse and that the facts, principles and deductions should be presented so that they can be readily grasped by the hearers. If the treatment is rambling, loose-jointed and discursive, those who compose the audience are apt to fall into a sort of mental disintegration, and a motion is apt to be made that "the discussion be closed" and an extinguisher is thus put on the whole matter.

The following are the general subjects on which reports are to be made at the Master Mechanics' Convention this year:

1. Exhaust Nozzles and Steam Passages—Continued.
2. Counterbalancing Locomotives.
3. Slide Valves.
4. Reciprocating Parts.
5. Cylinder Bushings.
6. Hub Liners.
7. Steam-Pipe Joints.
8. Driving-Box Wedges.
9. Steps and Handholds.
10. Truck Swing Hangers.
11. Locomotive Grates.
12. Thickness of Engine-Truck Wheel Flanges.
13. The Apprentice Boy.
14. To Harmonize Standards.

The regular hours for the sessions are from 9 a. m. to 2 p. m., the meetings being continued for three days, so that altogether 15 hours are devoted to the business and the transactions of the convention. Besides the reports on these subjects, there will be the opening exercises, the address by the President, reports of Secretary and Treasurer, and a considerable amount of routine business, which is quite sure to consume from two to three hours of the first day's meeting. From 10 to 1 o'clock on each day is usually devoted to the discussion of questions propounded by members. The election of officers, and other business usually consumes at least another hour, so that nearly half the time of the convention is occupied with business outside of the reports of the committees on technical subjects. There is therefore only from seven to eight hours left for their reading and discussion. As there will be 14 of them this year, there will be on an average, barely a half hour, which can be devoted to the reading and the discussion of each.

Last year* we made a rough estimate of the total cost of holding one of these meetings, which indicated that it was somewhere from $50,000 to $100,000. The ultimate purpose of this expense is to bring the members together for 15 hours to deliberate on the subjects which were selected a year ago and have been enumerated above. Each hour of this time therefore costs somewhat more than from $3,000 to $6,000, and the cost of the minutes is from $50 to $100, and the value of the seconds is nearly $1 to $2 each. It will therefore be seen how extremely expensive a windbag is or a number of them are on such occasions. Obviously economy of time is of the utmost importance, and a lengthy report is out of place. None of them should take more than fifteen minutes to read, and if they were confined to five or ten would be better. If the material collected by any of the committees is of such a character that it cannot be condensed so as to be read in that time then whatever would be excluded should be submitted with the reports in the form of appendices, to be printed, but not read, the committee giving only, in a general way, the methods and results of their investigations. The prodigal sons at these meetings are the members who waste the time by rioting in talk, and

"Idly running on with vain prolixity."

In view of the expense which is incurred, and the consequent cost of the time devoted to the meetings, it would seem as though it might be a good plan to have placards printed and posted and reading somewhat as follows:

The cost of holding these meetings is from one to two dollars for each second of time devoted to its deliberations, from $50 to $100 for each minute, and from $3,000 to $6,000 for each hour. Speakers are therefore requested to be as concise as possible and not waste the time, which costs so much, by observations not important or not relevant to the subjects under discussion, and it is suggested that each of them before speaking should calmly and interrogatively consider whether he would derive either entertainment or profit from listening to what he intends to say if it came from the mouth of another member.

There is, though, an obverse side to this view of the meetings, while the influences which detract most from their interest and profit is the loquacity of the bores and windbags, it is essential to the success of the meetings that those who are neither, and who are possessed of valuable experience, accumulated knowledge and of that kind of horizontality of mind which is of such great service to all of us in the perplexities and conduct of life, and who it may be, instead of being addicted to loquacity are disposed to be taciturn, should speak with the utmost freedom. Unfortunately no check-valve has ever been invented which will admit clear water to a boiler, but will close when that which is muddy is fed to it. An invention which would perhaps have still greater value, would be a sort of parliamentary check-valve, which would shut up the turgid speakers at meetings of deliberative bodies, and would open wide when a clear and pure stream of talk and thought is turned on. Many persons who are interested in the subjects which are to be reported on at the meeting which is now being discussed, would like immensely to learn what others know or think about some of them. It might not be a bad plan to request certain persons to consent to examination and cross-examination—after the manner which prevails in courts of justice—on some of the subjects in the above list. The writer confesses to an itching desire to cross-examine the Committee on Exhaust Nozzles and Steam Passages, and he would like to call some of the members of the Committee on Counterbalancing Locomotives to the stand with the privilege of asking questions to an unlimited extent, and probably no more interesting report could be made than that which might be compiled if the privilege were given to any one concerned in the subject to select certain members of the Association and ask them such questions as he liked with reference to whether it is safe to run pony trucks under fast express engines.

When a subject of importance is fairly brought before the Association, so that the members have a distinct comprehension of it, it is then of the utmost importance that discussion should in every way be promoted. If for a moment we consider the successive steps which have led up to this juncture, it will be seen how essential it is that nothing should interrupt the consideration of the subject which has thus been presented. In the first place, a year before the duty was imposed on a committee to select subjects for investigation. Having done this, another committee, who. it was assumed, were the fittest available persons for that task, was delegated with the duty of preparing a report, and during the year intervening they have given more or less time to the consideration and investigation of the matter submitted to them, and the Association has the right to expect that the committee will summarize all the available information and expense relating thereto which is accessible to them.

The members of the Association, who are fairly well paid men, give up their usual duties, travel hundreds or thousands of miles to attend these meetings, the purpose of which is to hear and consider such reports on subjects selected. A few hundreds of members there assemble together and are all avid and alert for information. A report is read under these circumstances. The Association may then be likened to a foundry cupola—it has been charged, the fire kindled, the blast turned on, and the metal is molten. The cupola is then tapped and the iron flows with vigor and brilliancy and could then all be drawn out and cast into useful forms. When at these meetings—to continue the similie—part of the metal has flowed out, a member who is not interested in the discussion will often rise and insert in the tap-hole a plug of cold clay, in the form of a motion that "the discussion be now closed." The motion is accepted, and the flow of discussion is than ended, and the molten thought which might have assumed useful form is allowed to cool and solidify in chaotic shape, and can then only be again brought to a fluid condition after much labor and time and heat has been expended on it. When an audience, having the knowledge, intelligence and experience which the members of the Master Mechanics' Association have, is prepared to hear and discuss a subject for the consideration of which they have come together, a sudden plugging up of the flow of mentality defeats the very purpose of their assembling together, and yet this is just what occurs over and over again through the action of some dull members who have, perhaps, not wit enough to be interested in or to comprehend the subject before the house. When the cupola has been heated the molds are ready and the metal molten, that is the time to draw it off and cast it into forms and objects which will be permanently useful. In other words, when an audience is assembled and is in an attitude of mind to deliberate on a subject, it is a waste of all the effort which has been made to bring it together to permanently stop the flow of ideas which are then fluid.

Quite a good many years ago it was suggested by Mr. Coleman Sellers, whose absence from these meetings for so long a time is so much to be regretted, that every report made to a body like this Association should end with a recommendation or resolution embodying the conclusions of the committee which made the report. Such resolutions would be open for discussion, and by being distinctly formulated would help to lead and to keep debate within limits which would be relevant to the matters at issue. Most of the committees could not do better than to end their reports with one or more resolutions, which, of course, would be submitted for adoption or rejection by the Association. Such resolutions would then represent the consummation of the committee's work, and would briefly summarize their conclusions.

*See *American Engineer* for July.

THE PROPOSED INTERNATIONAL STANDARD FOR SCREW THREADS.

The Swiss Government has invited European nations using the metric system of weights and measures to confer with it with the view of selecting and adopting a uniform gage for screws. As neither England nor the United States has adopted the metric system they have not been invited to participate in the councils of this convention. The decision of this conference will, nevertheless, be of great importance to the English-speaking nations. Great Britain already has a large foreign trade in machinery and manufactures that must ultimately be made to conform in detail measurements to metric standards, and American manufacturers, many of whom have been content for years with American markets, will eventually wake up to the fact that they must have foreign markets, if only to maintain a more even rate of production and minimize the effect on their business of the fluctuations in demand in the home markets. When this time comes we too will be concerned in metric screw threads and other standards which European manufacturing nations have adopted.

Fortunately for American manufacturers and engineers who are thus without representation in the decision of a matter which will some time be of such importance to them, the standard likely to be adopted is that of the French Admiralty. This gage closely resembles the Sellers threads, which are standard in this country. The shape of the French thread is identical with that of the Sellers, and the pitches for the various diameters closely resemble the Sellers, being on the whole somewhat finer, and each size being, of course, an integral number of threads per decimeter. If, therefore, we are ever required to adopt as our standard the decision of this convention, the new standard may be expected to conform closely to what the experience of our leading engineers and manufacturers have found to be desirable.

The time seems to be near at hand when international standards of measures and weights should be in effect in all civilized nations and not adopted by the few. This being the case, it would be fortunate if no action looking to the adoption of a standard of this kind would be taken without the co-operation of all. It may appear that in the selection of such a standard as metric screw threads, nations not at present using the metric system have no interests, but this is not so if there is anything in the idea that a uniform system of measurements is ever to be in force in all civilized nations. The earlier that all can have a share in the establishment of standards intended to be international, the sooner will the use of the standards become general.

The advocates of the metric system have urged upon the English and American public some so-called advantages of the system which can easily be shown to be a myth. The derivation of the unit of a system is of little or no importance, but the convenience of the sub-divisions of that unit and the extent to which the system is used, are of vital moment. We believe the convenience of the metric system and its general adoption in the countries whose markets American manufacturers and merchants will endeavor to enter or are even now striving to supply, will eventually lead to its adoption here. Great Britain and America cannot afford to use one standard of measures for home markets and another for foreign ones, and as the foreigners will not come to us, we will have to go to them in this matter. Even now the House of Commons in England has before it a measure to compel the adoption of the metric system in two years and there are rumors of a bill to be presented to Congress at Washington compelling the adoption of the same system in this country, by the year 1900. But it is questionable if such legislation will be enacted or if enacted will succeed in bringing about the desired result. Commenting on the English measure *Engineering* says:

As regards the possibility of carrying out the recommendations of the committee, we may say, in the first place, that it is very doubtful if the necessary standards could be prepared and verified in the time named. The manufacturers would probably contrive to produce the millions of measures of weight and capacity needed to replace those now in use, but unless the Government displayed unheard of activity, it is certain that the testing and stamping could not be done in that time. These matters, however, do not greatly affect engineers, as they seldom sell by lengths or weights, at least not in the sense that the shopkeeper does. Nevertheless, the change promises to provide them with troubles enough of their own to make them look forward to it with anxiety. It is one of those things every one wishes well over. That it will be enormously beneficial must be conceded by all. The time has gone past when it is necessary to furnish arguments as to the advantages of

the metric system over our own confused methods. Those whose business it is to deal with foreign countries know best how much they lose when they come into competition with manufacturers from Germany and Belgium, from the inability or indisposition of other nations to comprehend the standards we follow. We regard it is an absolutely foregone conclusion that the metric system will be adopted here, and the only points open to discussion are how the transition can be made most easily, and how far can advantage be taken of the change to establish certain international standards, which would have great commercial value.

If the above sentiments correctly represent the opinions of English manufactures, it will not be long before the United States must adopt the metric system or find itself alone in its opposition. If the change is once undertaken in the proper spirit it will probably prove less troublesome and expensive than expected, though it will be no trivial task.

The Tobacco Nuisance.

Our comments on the "abomination of expectoration" in cars and elsewhere, published in February, have called out the following letter from a correspondent:

I note what you say in your February number about the offensive habit which many people have of spitting on the floor in public conveyances or public places. The writer desires to thank you for your superlative utterances on this subject. I can endorse them all. But there is another intolerable nuisance which the suffering public has to bear, which is a more nauseous, execrable, offensive, odious, loathsome, horrible, detestable, foul, unwholesome, beastly and infectious practice than the other is or can be, and that is the intolerable nuisance of tobacco smoke, the long-suffering public has to bear as they travel in the crowded streets or congregate in public places. I, too, "am not a woman, nor the husband of one," but I am perfectly aware of the intolerable nuisance which tobacco smoke is to most women; but they have to grin (?) and bear it, because they cannot help themselves, and there is not more than one smoker in fifty who stops to consider whether their tobacco smoke is disagreeable to other people or not. The writer has a near friend who was at one time an inveterate smoker, but after a severe struggle gave up the habit, and now this same man tells me that he never knew before what an extremely selfish person he had been, and what a perfect nuisance he must have been for years by smoking.

Mr. Editor, Will you not kindly for the sake of women, as well as non-smoking men, who detest tobacco smoke, lend your pen to call the attention of selfish smoking men to the unmitigated nuisance they make of themselves, to the non-smoking part of the community, as they walk the crowded streets and burn incense to their idol. Can't we have a law in New York as they have in some other cities prohibiting any person from smoking in a crowded street?

Yours for comfort and cleanliness,
EAST ORANGE, N. J. R. A. HUTCHINSON.

The sentiments of our correspondent are those of the editor-in-chief of this paper. Similar opinions have also been held by—we were about to say—other distinguished men. Thus Dr. Oliver Wendell Holmes on being asked whether a young man should smoke, emphatically replied: "Certainly not. It is liable to injure the sight, to render the nerves unsteady, *to enfeeble the will* and enslave the nature to an imperious habit likely to stand in the way of duty to be performed."

Burton in the *Antomy of Melancholy* says: "Tobacco, divine, rare, superexcellent tobacco, which goes far beyond all panaceas, potable gold, and philosopher's stones, is a sovereign remedy in all diseases. *A good vomit*, I confess, a virtuous herb, if it be well qualified, opportunely taken and medicinally used; but, as it is commonly abused by most men, which take it as tinkers do ale, 'tis a plague, a mischief, a violent purge of goods, lands, health—hellish, devilish and damned tobacco, the ruin and overthrow of body and soul."

Another old worthy named Sylvester, who wrote a book or an essay on "Tobacco Battered," says:

> "Tobacconing is but a smoakie play,
> If their tobacconing be good, how is't,
> That lewdest, loosest, basest, polishest,
> The most unthrify, most intemperate,
> Most viscious, most debaucht, most desperate
> Pursue it most?"

The same writer also says:

> "A tabacconist, I dare aver,
> Is first of all a rank idolater."

Again he says:

> "Hell hath smoak,
> Impenitent tobacconists to choak."

Professor Reynolds, in an address delivered some years ago before the Hospital College of Medicine, said:

"It is a well-known fact that tobacco deranges the digestion and poisons the nerve centers of a majority of the male members of the human family. A species of blindness, not complete, but partial blindness, sufficiently great in extent to destroy the reading of ordinary type, results from the continued and excessive use of tobacco. Careful investigations have led to the discovery that that form of tobacco habit known as smoking produced the so-called amblyopia. This form of amblyopia is precisely identical in all respects with that produced from the excessive use of alcohol. Both are incurable. . . .

"Smoking tobacco has never been known to result beneficially to any person in the world. *It always lessens the sense of smell and taste;* it always contaminates the breath: it always creates an unsteadiness of the muscles, through its irritating effect upon the nerves; and I know from personal experience it diminishes the capacity for mental labor."

The celebrated Dr. Döllinger said on the same subject:

"The eternal smoking of pipes and cigars by our forefathers doubtless helped to bring about the short sight which has now become hereditary in Germany. Tobacco-smoking is the ruin of society and of chivalrous conduct towards women. The tone becomes less refined, conversation suffers from it. For a long time I have avoided any society where smoking is allowed, and often travel first-class in the railway solely to escape the disagreeable, unwholesome atmosphere."

At a meeting of the Anti-Tobacco Society, held in Manchester, England, some years ago, the statement was made "that careful statistical investigation has shown that teetotallers who smoke are five times more liable to fall away than those who do not."

Medical authorities are agreed that, taken in moderate quantities it calms restlessness and produces a state of gentle langour or repose; or acts as a harmless excitant and sedative, but "yet it is a frequent cause of paralysis when the practice is indulged in to excess. Oil of tobacco which is inhaled and swallowed in the process of smoking, is one of the most violent of known poisons. The Hottentots are said to kill snakes by putting a drop of it on their tongues, and the death of these reptiles is said to take place as instantaneously as if by an electric shock."

There have been occasions when we have been inclined to regrett that this poison of tobacco was not as deadly to some smokers as it seems to be to venimous serpents. That the habit is attended with some risks is shown by the following tale told by the *British Medical Journal*. That paper says:

"A gentleman was ordered some ordinary chlorate of potash lozenges for a sore tongue, and for convenience he kept them loose in his waistcoat pocket, as scores of people have done before. Now, as ill-luck would have it, this gentleman also bought a box of Swedish safety matches, and these he also put into the same pocket. Now, a moment's consideration of what a safety match is tells us at once the whole catastrophe. To prevent matches going off of themselves the makers separate the ingredients, putting the phosphorus on the box and the chlorate of potash on the matches. While bending down to pick up something on the floor the lozenges rubbed against the friction paper on the outside of the box. This set the entire box alight, and the heat kindled all the matches in the box. The heat generated decomposed the chlorate lozenges, and the oxygen set free intensified the combustion tenfold. The result was the gentleman was instantly in flames, the combustion being of explosive violence. Had not a pail of water been thrown over him instantly the result must have been fatal, as the combustion was inconceivably violent.

Amaurosis, which it is said is produced by smoking, is defined to be "a loss or decay of sight from loss of power in the optic nerve, without any perceptible external change in the eye."

A much worse—and it is believed a common effort is what may be called mental and moral amaurosis or the weakening of what may be called the nerves of the mind, will and moral perception. A common symptom of this condition is the lack of perception by smokers, as our correspondent says, "that they are making nuisances of themselves." When a smoker with much indifference puffs his vile vapors, as they often do, into the faces of persons to whom it is disagreeable, it can only be attributed to two causes—either to mental dullness, that is inability to know that it is disagreeable, or to moral strabismus or lack of consideration for the comfort of those about them.

This leads up to what is the real purpose of this article which is smoking at technical meetings—such as those of Railroad Clubs, the Conventions of the Mechanical Engineers, Master Mechanics and Master Car Builders. At the January meeting of the New England Railroad Club this subject was brought up by Mr. Chamberlain who said that complaint is made that smoking during the sessions of the club is very embarrassing to those who do not use the weed—that is to some. It clouds the room, which finally causes the window to be opened to let the smoke out, the result being that there is great liability to catch cold, and in deference to these members who do not smoke, it has been suggested that a motion be made prohibiting smoking, in order to get the sense of the club with reference thereto. On motion of Mr. Adams, it was decided that from this time forth there should be no more smoking, which was unanimously carried. Not only is smoking very disagreeable to many people, but, as is claimed by those who practice it, it is a sedative and produces a state of languor or repose. That is instead of stimulating thought and mental activity, it has the reverse effect. Now the purpose of meetings, such as has been referred to, should be to stimulate thought, and thus excite discussion and not repress it. Any careful observer can see at such meetings that just as soon as cigars are distributed, and the audience is converted into a fumous body, that interest in the subject before the meeting is lessened, discussion lags and attention is diverted. When a man converts his mouth to the uses of a smoke-stack he consciously or unconsciously loses much of the gift of discussion. It is not quite certain what substances can and what cannot be penetrated by the Röntgen X rays that we have heard so much about lately, but it may safely be assumed that it is difficult for any one either to absorb or convey any very profound thought, which must penetrate through clouds of tobacco-smoke, in passing from the speaker to the hearer. Smoking detracts much from the dignity of such meetings, it lessen the interest in the subjects under consideration, it blunts the perceptions of the audience, and defeats what ought to be the main object in coming together. It is, therefore, moved, in the words of Mr. Adams, that "from this time forth we have no more smoking at these meetings."

Personal.

Mr. Henry McHarg has been elected President of the Texas Central.

Mr. M. C. Grace has resigned the position of Master Mechanic of the Monterey Mineral & Terminal Railway.

Mr. P. Maher has been appointed Master Mechanic of the Indiana, Illinois & Iowa Railway, vice Mr. L. H. Miller, resigned.

Mr. John Purcell has been made Assistant Master Mechanic of the Atchison, Topeka & Santa Fe at Argentine, Kan., in place of Mr. J. Forster, promoted.

Mr. John K. Cowen, President, and Mr. Oscar G. Murray, First Vice-President of the Baltimore & Ohio, were on Feb. 29 appointed receivers of that road.

Mr. H. G. Bowles, General Manager of the Monongahela River Railroad, has been appointed General Superintendent, and Mr. J. A. Feckinger succeeds him as General Manager.

Mr. W. A. Mills, Assistant to the late President of the Columbus, Hocking Valley and Toledo road, has been appointed General Manager of that road, with headquarters at Toledo.

Mr. Merle Middleton has resigned the position of Western Manager of the Safety Car Heating & Lighting Company to become associated with the Standard Steel Works of Philadelphia.

Mr. Hiram S. Cable, son of Mr. R. R. Cable, President of the Chicago, Rock Island & Pacific, has been appointed to the position of Vice-President and General Manager of the Rock Island & Peoria.

Mr. E. L. Chapman has been appointed Assistant Superintendent of Motive Power of the Southern Railway, to succeed Mr. Thomas, who, as noted last month, was promoted to the head of the department.

Mr. C. B. Hart, for several years a Traveling Freight Agent for Chicago, Rock Island & Pacific, has resigned, and will become General Manager of the Hutchison & Southern, a line of 80 miles in Southern Kansas.

Mr. Wm. Taussig has resigned the presidency of the St. Louis Terminal Association because of ill health, and is succeeded by Mr. J. S. Walsh, formerly Vice-President. Mr. E. P. Bryan, General Manager becomes Vice-President.

Mr. Theodore Klein, now General Superintendent of the Central of Georgia, will on May 1st, take the position of General Manager of the Inter-Oceanic Railway, of Mexico. Mr. Klein was formerly on the Mexican National Railway.

Mr. T. E. Adams, Master Mechanic of the Northern Division of the Great Northern Railway Line, has been appointed Superintendent of the Dakota Division of that road, and Mr. T. E. Cramer has been appointed Master Mechanic in his place.

Mr. T. W. Demorest has been transferred from the position of Assistant Engineer in the Motive Power Department of the Pennsylvania lines at Columbus, O., to be Assistant Master Mechanic at the Indianapolis shops of the company.

Mr. William J. Morden, recently the head of the Morden Frog & Crossing Works, died at his home in Chicago last month. The plant of the company in which he was so prominent was started about 1880 at Chicago. The present large plant at South Chicago was erected in 1884.

Mr. Joseph B. Stewart has been appointed to succeed Mr. Wm. G. Wattson, deceased, as Superintendent of the Hudson River division of the West Shore Railway, and Superintendent of the Wallkill Valley and Jersey Junction roads. Mr. Stewart was formerly Superintendent of Telegraph and Signals.

Mr. E. Dawson has been appointed General Master Mechanic of the Kansas City, Pittsburgh & Gulf Railway, with headquarters at Pittsburgh, Kan. Mr. Dawson was formerly Superintendent of Machinery of the Des Moines & Kansas City Railway, which position he resigned to accept the appointment mentioned.

The death of Mr. N. J. Paradise has resulted in several changes in the mechanical department of the Burlington system. Mr. F. A. Chase has been made Master Mechanic of all the Missouri lines, with headquarters at St. Joseph, Mo., and Mr. I. N. Wilbur has been appointed Division Master Mechanic at Hannibal, to succeed Mr. Paradise.

Mr. Charles G. Waldo, General Superintendent of the Cincinnati, Hamilton & Dayton, succeeds Mr. Wm. M. Greene as General Manager of that road. Mr. Waldo was formerly on the Michigan Central and went to the Cincinnati, Hamilton & Dayton in 1889 as Purchasing Agent. He was then promoted to Assistant to the President, General Superintendent, and now is made Manager of the road.

Mr. Robert B. Campbell, General Manager of the Baltimore & Ohio Railroad, has resigned and has been succeeded by Mr. William M. Greene. Mr. Campbell went to the Baltimore & Ohio in 1892, and became General Superintendent of the Trans-Ohio Division. He became General Manager in 1893. His successor, Mr. Greene, was formerly General Manager of the Cincinnati, Hamilton & Dayton Railway.

Mr. George B. Hazlehurst has resigned the position of General Superintendent of Motive Power of the Baltimore & Ohio Railroad, which he has held since 1891. He entered the Baltimore & Ohio service when a boy, serving first as a clerk, and afterward with surveying parties, until he became assistant surveyor. He was later transferred to the bridge department, where he remained until made superintendent of motive power.

Mr. W. H. Canniff has been appointed General Manager of the Lake Shore & Michigan Southern, and Mr. P. S. Blodgett, General Superintendent. Mr. Canniff has been General Superintendent since 1890, and was previously Division Superintendent on the Lake Shore for many years. Mr. Blodgett had also been a Division Superintendent of the Lake Shore for years, until 1892, when he was made Assistant General Superintendent.

George H. Nettleton, President and General Manager of the Kansas City, Fort Scott & Memphis Railroad, died of paralysis in Kansas City, Mo., March 26. Mr. Nettleton was one of the best known railroad men in the West, and was 65 years old. He was born in Chicopee Falls, Mass., Nov. 13, 1831, and first entered the railroad service on March 7, 1851, as rodman on the New Haven & New London Railroad, of Connecticut, which afterward formed a part of the shore line of the New York, New Haven & Hartford Railroad.

Mr. Harvey Middleton, recently Superintendent of Construction at the Pullman works of the Pullman Palace Car Company, has been appointed General Superintendent of Motive Power of the Baltimore & Ohio Railroad. Mr. Middleton was appointed superintendent of machinery on the Louisville & Nashville in 1884. Five years later he went to the Atchison, Topeka & Santa Fe, and shortly afterward became superintendent of motive power and machinery of the Union Pacific, which position he held until he went with the Pullman Company.

James H. Stewart, formerly General Manager of the Cincinnati, Washington & Baltimore, was found dead in his room at Sandusky, March 15, having been suffocated by natural gas escaping from a stove. Mr. Stewart was born at Rochester, N. Y., May 8, 1827, and began railway work in 1848, on the Rochester & Niagara Falls road. From 1853 to 1858 he was superintendent of construction on the Wabash, and for the next nine years was General Superintendent of the Sandusky, Mansfield & Newark. From 1867 until 1874 he was General Superintendent of the Winona & St. Peter. He was General Manager of the Cincinnati, Lafayette & Chicago from 1875 to July, 1879, and was General Manager of the Marietta & Cincinnati from 1879 to 1881. In 1883 he was made General Manager of the Cincinnati, Washington & Baltimore, which position he held until Jan. 1, 1890. He was active in the construction of the Sandusky & Hocking, and was a director of that company.

William A. Parry, son of Charles T. Parry, late of the Baldwin Locomotive Works, of Philadelphia, died in British India on February 8. Mr. Parry was left a large estate. He was 35 years old, and started in October last for a tour of the world. He had reached the base of Mount Everett, near Calcutta, when he died. His friends in this country have not yet learned the cause of his death. Mr. Parry was owner of the schooner yacht *Telfer*. He was a member of the New York Yacht Club and one of the founders of the Corinthian Yacht Club of Philadelphia, of which he was for a time vice-commodore. He was also a member of the Bachelors' Barge Club, Union League and Art Club in Philadelphia, and a member of the Colonial Club, of New York. He leaves a wife and one child. The body is on its way home, and will be buried in Philadelphia.

William G. Wattson.

Mr. William G. Wattson, Superintendent of the Hudson River Division of the West Shore Railroad, died on March 10 from the effects of wounds received March 5, at the hands of a discharged employee. Edmund Clifford, who had been employed by the road as a detective, was discharged for drunkenness, and went to Mr. Wattson's office, while under the influence of liquor, to complain of his discharge. After a brief parley he drew a pistol and fired at Mr. Wattson several times, the second shot wounding him fatally.

Mr. Wattson was the son of a clergyman, and was born in Prince George County, Maryland, in 1854. He entered railroad service as a telegraph operator, and served as operator, station agent, dispatcher, etc., on the Queen Anne & Kent County, Huntington & Broad Top and Allegheny Valley Railroads. He entered the service of the West Shore in 1883, and for several years was car accountant. He became superintendent in 1890. He took an active interest in the work of the Car Accountants' Association, American Railway Association, American Society of Railroad Superintendents, the New York Railroad Club and other societies. He occupied the office of secretary of the latter society at the time of his death. He was an energetic worker, and widely known and respected in railroad circles. He leaves a wife and three daughters.

Nathaniel W. Pratt.

Through the announcements in the daily papers most of our readers will have learned before this notice reaches them of the death of Nathaniel W. Pratt, President of the Babcock & Wilcox Company, which occurred on March 10, at his home, in Brooklyn, N. Y.

He was descended from old New England ancestry, who on both his father's and mother's side settled in Plymouth County, Mass., in 1630, although he was born in Baltimore in 1852, and was therefore, 44 years of age at the time of his death.

He inherited from his father—who during the war was superintendent of the Burnside armories in Providence, R. I.—an aptitude for mechanics, and in 1870 he entered the employ of the firm of Babcock & Wilcox, who were then manufacturing boilers and engines. Through his energy and remarkable business qualifications he soon gained the confidence of his employers. In 1881 the firm was organized into a corporation, and he was then appointed Treasurer and Manager of it. He filled these positions until 1893, when, on the death of Mr. Geo. H. Babcock, one of the founders of the original firm, he was elected President of the company which position he held until the time of his death.

He had the rare characteristic of combining engineering and inventive ability with remarkable capacity for conducting business affairs, and it was to his exertions largely that the remarkable success of this company was due. In 1884 he became consulting engineer to the Dynamite Gun Company, and it was from his designs and under his patents that the first successful dynamite gun, which was of 8-inch caliber and 60 feet long, was built, and it was with it that the experiments at Fort Lafayette, in New York harbor, were made in throwing torpedoes.

He was for 25 years associated with the Babcock & Wilcox Company and firm, and the growth of that establishment and the success of its business was largely due to his business sagacity and sound judgment, and it now occupies the position of being one of the largest boiler manufacturing companies in the world, and it is to it that the success of water tube boilers is largely due. Mr. Pratt was energetic and aggressive in the conduct of business affairs, but also had the reputation of being generous and of a kindly disposition towards those less favored by fortune than he was.

He was a member of the American Society of Mechanical Engineers, the American Institute of Mining Engineers, American Naval Institute, and of the Engineers' Club of New York. His aged father and mother, his wife and three children survive him.

Notes.

An accurate measurement of coal consumption and horse power of a 22 and 40 by 48-inch, Reynolds-Corliss condensing engine for three years shows that in 1893 an average of 381 horse power was obtained on 1.76 pounds of coal per horse power per hour, in 1894 an average of 393 horse power at, 1,67, and in 1895 an average of 396 at 1.65 pounds. The engine and boilers, which were also of the Reynolds type, were at the Stevens Linen Works at Webster, Mass. The owners of the plant obtained the figures, and they state that they indicated the engine morning and afternoon and carefully weighed all coal.

A section of a combined parlor and sleeping car from the designs of L. F. Ruth has been recently constructed at the shops of the Pittsburg and Lake Erie Railroad. Pneumatic cushions are used for berths and chairs and the berths are stored in casings on the sides of the car which do not interfere with light or ventillation. The collapsed mattresses occupy but little space and when the berths are made up the parlor chairs are stored between the floor and the lower mattress, being removed from their bases which are large enough to contain the bedding.

Four pumping engines each of 20,000,000 gallons daily capacity have recently been built by the Southwark Foundry & Machine Company for the city of Philadelphia. The engines are of the verticle, triple-expansion type and have cylinders 37, 62, and 96 inches in diameter, and three single acting pump plungers 34½ inches in diameter, all of 54-inch stroke. The total weight of each engine proper is about 1,000,000 pounds, or 2,000 tons, for the four engines, and the pumps and their attachments add 2,500 tons to this amount. A noteworthy feature of this pumping plant is the substitution of steel structural work in place of the usual cumbersome and expensive masonry work for the support of the engines. This construction gives easy access to all parts of the water end for examination, and in case of necessity the pump chambers can be removed and replaced with but little work. The Southwark Foundry has been the first to use this method of construction for supporting engines and had found it to be perfectly rigid. The engines described have run noiselessly and with little vibration, and there is every reason to suppose that the supports will be as rigid as a masonry foundation. The plant was fully described in a paper by Mr. T. H. Mirkil, Jr., before the Engineers' Club of Philadelphia.

From a circular recently issued by the Forestry Division of the Department of Agriculture it appears that careful estimates place the forest area of the United States (exclusive of Alaska) at about 500,000,000 acres, and that there are standing ready for the ax a total of 2,300,000,000,000 feet, board measure, of lumber of all kinds. The annual cut is 40,000,000,000 feet. Adding the consumption for fuel, fence material, waste in the woods and at the mills brings the total annual wood consumption of the country up to 25,000,000,000 cubic feet, or about 50 cubic feet per acre of forest, which is equivalent to the yield per acre realized in the well-kept forests of Prussia, where reproduction is secured by skillful management.

Mr. F. H. Stark, master car builder of the Cleveland Lorain & Wheeling, informs us that he has substituted metal head lining in place of cloth in some of the road's old passenger cars. Suitable designs can be found such as are used for small rooms, with raised work not too bold and quite appropriate for coach headlining. As a rule, stamping works make the sections in squares 2 ft. by 2 ft., but he got the last lot in sections 2 ft. by 8 ft. They are secured to the ceiling with lap joints without battons. He thinks there is a possibility of some trouble with joints opening after a while so as to be noticeable. He paints the lining a drab color that will not show the effect of smoke and yet make the car light. This is quite a departure in the way of color, but it has a good effect. The cost is so reasonable and the work so permanent that it is worthy of consideration on the part of those seeking economy.

The North of England correspondent of *The Engineer* writes to that paper:

"A new departure in marine engineering has been made at West Hartlepool, where the *Inchmona*, a new screw steamer, is to be fitted with the first set of Mudd's patent five-cylinder and four-crank engines, with boilers working at a pressure of 255 pounds per square inch under induced draught. Mr. Thomas Mudd, the inventor, is the Mayor of Hartlepool, and is the managing director of the Central Marine Engine Works, which will supply the engines. The object of the invention is to obtain a greater economy of fuel than has been possible with the triple-expansion engine. It is little more than thirty years since the introduction of the compound engine with a boiler pressure of 65 pounds."

The *Engineer* is authority for the statement that the cogwheel and rach railways of the world include 70 lines built since 1812; and of these 17 are in Switzerland, 14 in Germany, 12 in Austria-Hungary, 4 in France and 3 in Italy, the others being in England, Spain, Greece, Portugal, the United States, South America, Asia and Australia. The total length of these lines is 500 miles, of which 188 are of the Abt system. These lines are worked by 300 locomotives, the heaviest of which weighs 70 tons.

The committee on the supervision of the standards and recommended practice of the Master Car Builders' Association will be glad to receive suggestions in reference to any such modifications of the established standards and recommended practices of the association as are justified by experience in their use. Members believing changes or additions should be made to any of these standards should communicate with Mr. R. H. Soule, chairman, Roanoke, Va.

The committee of the Master Mechanics' Association that is to report on "What kind of grate is most suitable for burning anthracite coal—cast-iron shaking or watar bar?" has issued a circular of inquiry containing 35 questions. We have not the space to publish this important circular, but the members having information on this subject can render good service to the committee and the association by sending answers to the questions to Mr. Ed. L. Coster, 10 Wall street, New York City.

The latest schedule of the Philadelphia & Reading railroad shows that a new train has been put on that makes the trip from Philadelphia to New York in 1 hour and 45 minutes, or 15 minutes shorter than the fastest previous schedule. The train has three vestibuled cars weighing about 100 tons, and is hauled by a Vauclain compound locomotive with a single pair of drivers 84½ inches in diameter. The engine has a leading four-wheeled truck with 36-inch wheels, and a pair of trailing wheels under the firebox that are 54½ inches in diameter. The cylinders are 13 and 22 inches in diameter and 26 inches stroke. The boiler has 1,460 square feet of heating surface and carries a pressure of 200 pounds. The weight on the drivers is 48,000 pounds and the total weight of the engine is 110,500 pounds. The train leaves Philadelphia at 8:20 a. m. and arrives at Jersey City, 90.2 miles, at 9:53, making two stops, and averaging 58.3 miles per hour. The time for one stretch of 75½ miles is 70 minutes, or 64.7 miles per hour. Westbound the time is five minutes slower.

It has been found by several of the prominent roads entering Chicago that the boring of locomotive tires need not be the expensive and lengthy job it is usually found to be. By increasing the feed, and if necessary, using water on the tools to keep them cool, the work can be greatly ac-

celerated. A 50-inch tire can be bored in less than an hou and where one man has more than one machine to operate the cost of boring a tire of this size need not cost the company more than 25 cents. The larger tires cost proportionately more.

The trustees of the New York and Brooklyn Bridge, at a meeting held March 23, adopted the report of Superintendent Martin recommending that electric motors be used for switching trains at the terminals. It is expected that twenty cars will be equipped with motors, each car being provided with four of 62½ horse-power each. This will give a maximum drawbar pull of 6,000 pounds. These motors are expected to haul trains over the bridge in the early morning hours, or at other times should the cable fail. The Superintendent was instructed to prepare plans and specifications for the installation, and to advertise for bids for electric heaters for these cars. The cost of the power house and the machinery is estimated at $300,000. The Executive Committee of the trustees recommends that the contract for the motors be awarded to the General Electric Company on its bid of $3,645 a car.

Economical Designing of Timber Trestle Bridges.

Bulletin No. 12 of the timber physics series being issued by the United States Department of Agriculture contains an article under the above caption from the pen of A. L. Johnson, C. E., with several letters of comment upon it from prominent engineers. The article begins by showing that there are 2,000 miles of timber trestle in this country costing more than $60,000,000 and requiring replacement, on an average, every nine years. The need of economy in the design is thus apparent. Data from the present practice of railroads shows that there is no uniformity in design, the factor of safety in beams running from 1.5 to 13, and the factor for endwise crushing ranging from 2.6 to 25. Other irregularities in present practice are shown, and then under the head of "Recommended Practice" the author says:

Since the strength of timber varies very greatly with the moisture contents (see Bulletin 8 of the Forestry Division), the economical designing of such structures will necessitate their being separated into groups according to the maximum moisture contents in use.

MOISTURE CLASSIFICATION.*

CLASS A (moisture contents, 18 per cent.).—Structures freely exposed to the weather, such as railway trestles, uncovered bridges, etc.

CLASS B (moisture contents, 15 per cent.).—Structures under roof but without side shelter, freely exposed to outside air, but protected from rain, such as roof trusses of open shops and sheds, covered bridges over streams, etc.

CLASS C (moisture contents, 12 per cent.).—Structures in buildings unheated, but more or less protected from outside air, such as roof trusses or barns, inclosed shops and sheds, etc.

CLASS D (moisture contents, 10 per cent.).—Structures in buildings at all times protected from the outside air, heated in the winter, such as roof trusses in houses, halls, churches, etc.

The following tables of safe loads have all been made out for Class A, with the intention of making them applicable to bridge-trestle construction. To make these applicable to the other classes make the following modifications:

For longleaf pine add to all the values given in the tables, except those for moduli of elasticity, tension and shearing, for Class B, 15 per cent.; for Class C, 40 per cent., and for Class D, 55 per cent. For the other species add to these values, for Class B, 8 per cent.; for Class C, 18 per cent., and for Class D, 25 per cent.

For the modulus of elasticity add only one-half of the above percentages. For tension and shearing use the tubular values—whatever the percentage of moisture.

For longleaf and shortleaf pine these modifications are quite correct, the percentage of increase of strength of the former being about twice as great as that for the latter between the green and dry conditions. This percentage of increase is not so well known for the other species, but tests that have been made indicate a percentage of increase at least as large as for shortleaf pine. Until further tests have been made, therefore, the modifications given above may safely be used.

*The reductions for moisture as given above in the case of longleaf pine appear somewhat at variance with results obtained since. In the case of other species they rest on assumption, for which experimental data are still largely lacking; it will, therefore, be proper to use the same with caution.

The moisture condition at 18 per cent. is one difficult to obtain under natural conditions; it would, therefore, have been more desirable if the author had started from the green condition, which is fixed. The following values for green condition are here added for the four Southern pines, on which alone the Forestry Division has reliable data:

	Moisture condition.	Cuban pine.	Longleaf.	Loblolly.	Shortleaf.	Average change.
Transverse strength or modulus of rupture, green	Per cent. 33	6,150	6,200	5,830	5,230	.....
Compression endwise, green	33	4,150	3,660	3,430	3,460	.....
Relative strength as a mean of transverse and compression:						
Green	33	100	100	100	100	100
Half dry	20	125	119	122	120	122
Yard dry	15	149	148	147	138	146
Room dry	10	182	194	187	165	183

B. E. FERNOW.

SAFE UNIT STRESSES.

TABLE IV.—*Safe unit stresses at 18 per cent. moisture.*

[The values marked "D" were obtained from experiments made by the Forestry Division. The other values were obtained from various sources, chiefly the Tenth Census report, but so modified, as to give results comparable with Forestry Division values. To arrive at true average values of strength, multiply safe loads by factor of safety given in each column. The values for resilience and tensile strength are the *ultimate* values. The former is practically never used in designing. The latter is a factor impossible to develop in practice, since the piece will always fail in some other way, usually by shearing. (See descriptive text.)]

Species.	Modulus of strength at rupture per square inch.	Modulus of elasticity per square inch.	Elastic resilience per cubic inch.	Crushing strength endwise per square inch.	Crushing strength across the grain per square inch	Tensile strength per square inch.	Shearing strength per square inch.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Longleaf pine (*Pinus palustris*), D	1,550	720,000	1.30	1,000	215	12,000	125
Shortleaf pine (*Pinus echinata*), D	1,300	600,000	1.30	840	215	9,000	100
White pine (*Pinus strobus*)	880	435,000	1.00	700	147	7,000	75
Norway pine (*Pinus resinosa*)	1,090	566,000	.....	760	143	.....	.....
Colorado pine (*Pinus ponderosa*)	980	444,000	.....	630	180	.....	.....
Douglas fir (*Pseudotsuga douglasii*)	1,320	690,000	.....	880	167	.....	.....
Redwood (*Sequoia sempervirens*)	1,440	226,000	.....	650	115	.....	.....
Red cedar (*Juniperus virginiana*)	1,000	335,000	.....	700	250	.....	.....
Bald cypress (*Taxodium distichum*), D	1,000	450,000	1.10	675	120	6,000	60
White oak (*Quercus alba*), D	1,200	550,000	1.25	800	400	10,000	200
Factor of safety	5	2	1	5	3	1	4

Table IV. is a table of safe unit stresses† of the various kinds for the materials employed in the construction of timber trestles. The "safe unit stress" is equal to the ultimate strength, as determined from the test, divided by a quantity which is called the factor of safety.

In designing add one half inch to each dimension obtained by use of above table to allow for weathering.

The values marked "D" in the table are considered quite reliable, especially those for longleaf and shortleaf pine. These are for a moisture of 18 per cent., representing a half dry condition, and were taken from a minimum moisture curve which represented the average strength of the lowest 10 per cent. of the non-defective pieces tested. This curve gives values from 15 to 20 per cent. less than the mean values obtained for the species, and material of this strength can readily be obtained even for full-sized beams and columns by an inspector of average intelligence.

The other values were obtained from various sources, chief of which was the Tenth Census report.

The information for these species is very meager, but the values given are considered safe, though probably not as economical as they might be if more extensive tests had been made.

As will be seen from an inspection of Table IV., the factor of safety is not a constant quantity, but ranges from 2 to 5. In general, any composite structure should be of equal strength in all of its parts. This does not mean that they should all have the same factor of safety.

The values given for the modulus of elasticity for all the species except redwood and cedar will give, for the average conditions, a deflection equal to about one two-hundredths of the span, which has been assumed as the maximum allowable. This is about equal to a factor of safety of 5 on the total deflection at rupture. The exceptions to this are the two species above mentioned, but these are not used for beams.

The crushing strength across the grain in Table IV. is based upon a crushing of 3 per cent. of the cross-sectional height of the piece. This point may be compared to the elastic limit in the cross-breaking tests. While absolute failure does not occur at this point, yet it is a point beyond which it is unsafe to go. The point of absolute failure in this test is, more or less, an imaginary point, and the above percentage of crushing has been selected as an arbitrary representative thereof. As failure does not occur here, however, a factor of safety of 3 is deemed necessary and sufficient for this kind of a load.

INSPECTION.

Scientific inspection of timber requires a knowledge of the elements affecting the strength thereof.

The following are the principal elements: Moisture condition; weight per cubic foot; size of piece; position in tree; defects, such as knots, cross-graining, ring shakes and season checks; anatomical structure; character of the secretions, such as resin, etc.; method of treatment previous to use.

Moisture condition.—This is the chief element affecting the strength of timber. The strength of a thoroughly seasoned piece is from 50 to 100 per cent. more than that of a green piece. To say that a certain piece of timber has a strength of a certain amount is of no service whatever in determining its relative strength unless the moisture condition is specified.

Weight.—In material of the same species, having practically the same anatomical structure and character of secretions, the strength varies directly as the weight for the same condition of moisture.

Size of piece.—This has some effect, but it is much less than has been generally supposed. The chief difficulty is in the seasoning of large pieces. If this is done carefully no allowance need be made in the safe loads given on account of size, except for more frequent defects.

Position in tree.—The strength varies with the position in tree. In old trees of pine, from 150 to 200 years of age, the strongest portion of the butt log will be at about one-half the radius from the center. As we go higher in the tree, the central part, though weaker than in the butt log, becomes the strongest portion of the cross-section.

Defects.—Large knots should not be allowed to come at the middle of a beam, either on top or bottom, as they are a source of weakness in compression as well as in tension, though not quite to the same extent. The fibers around a knot run nearly at right angles to the axis of the tree, so that in a compression test these fibers are subject to a crushing strength across the grain, in which direction they are very weak.

Season cracks on top of a beam have little effect upon the strength, except as they may collect water and start rot. Those, however, on the side of a beam near the neutral plane, which for timber is usually a little below the middle, are very injurious, as they greatly increase the liability to shear along this plane.

Wooden beams, as ordinarily employed, are more apt to fail in this manner than in any other way. By putting a

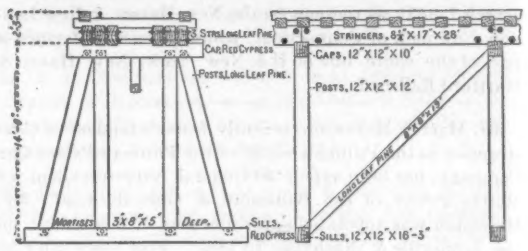

3 STRS. LONG LEAF PINE
CAR RED CYPRESS
POSTS, LONG LEAF PINE.
STRINGERS, 8½" X 17" X 28'
CAPS, 12" X 12" X 10'
POSTS, 12" X 12" X 12'
LONGLEAF PINE 8½" X 17"
MORTISES
3" X 8" X 5"
DEEP.
SILLS, RED CYPRESS
SILLS, 12" X 12" X 16'-3"

Fig. 1. Present Practice.

bolt in each end of large beams, thus firmly holding the top and bottom portions together, this danger could be largely avoided. Ring shakes are also prime causes of shearing along the neutral plane.

Anatomical Structure—This has, of course, great influence upon the strength of timber, and to it is largely due the difference in strength between the different species.

But little is known about this subject as yet, except in a general way, as, for example, regarding pine and oak.

The present time is a little premature for the formulation of full rules for scientific inspection of timber. We only know that for strength we require dry timber, and for a given species the heavier the stronger.

For the present it is impossible to evaluate the effect of knots and other defects, but we should guard against them as far as possible.

The safe loads given in the tables herein will then be perfectly safe, and apply to all sizes.

METHODS OF DESIGNING.

PRESENT PRACTICE.

Many of the railroad companies now use a safe load of 1,000 pounds per square inch for the modulus of rupture for longleaf-pine stringers. The caps, sills, and posts are usually 12 by 12 inches, irrespective of load.

Fig. 1 represents a common type of construction designed by the above considerations and for the following con-

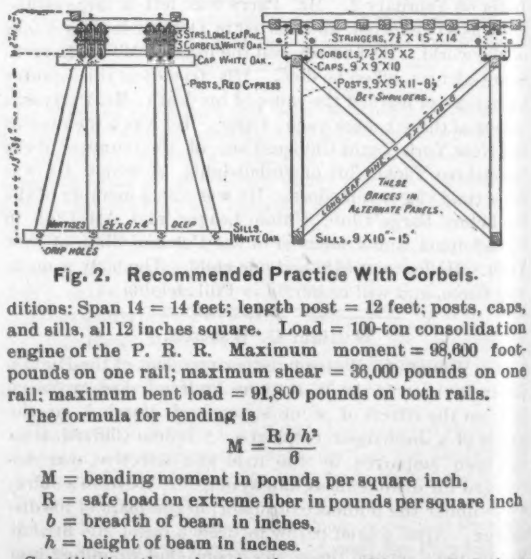

3 STRS. LONG LEAF PINE
2 CORBELS, WHITE OAK
CAP WHITE OAK.
POSTS, RED CYPRESS
STRINGERS, 7½" X 15" X 14'
CORBELS, 7½" X 9" X 2
CAPS, 9" X 9" X 10
POSTS, 9" X 9" X 11'-8½"
BEV SHOULDERS.
LONGLEAF PINE 7½" X 15"
TRUSS BRACES IN ALTERNATE PANELS.
MORTISES
2½" X 6" X 4"
DEEP
SILLS, WHITE OAK
SILLS, 9" X 10" - 15'
DRIP HOLES

Fig. 2. Recommended Practice With Corbels.

ditions: Span 14 = 14 feet; length post = 12 feet; posts, caps, and sills, all 12 inches square. Load = 100-ton consolidation engine of the P. R. R. Maximum moment = 98,600 foot-pounds on one rail; maximum shear = 36,000 pounds on one rail; maximum bent load = 91,800 pounds on both rails.

The formula for bending is

$$M = \frac{R\,b\,h^2}{6}$$

M = bending moment in pounds per square inch.
R = safe load on extreme fiber in pounds per square inch
b = breadth of beam in inches,
h = height of beam in inches.

Substituting the values for these quantities, we find there will be required three stringers under each rail, 8¼ by 17 inches in cross-section, posts, caps, and sills all being 12 by 12 inches in cross-section.

The following factors of safety are indicated by their practice:

Stringers in cross-breaking	7.6
Stringers in deflection $\frac{1}{100}$ span	3.1
Stringers in bearing value	2.7
Cap, bearing value under stringers	1.5
Cap, bearing value under posts	1.9
Posts, crushing endwise	24.6

† From the cross-breaking test are obtained the modulus of strength at rupture (R), the modulus of elasticity (E), and the elastic resilience per cubic inch (r). *The modulus of strength at rupture* is the intensity (in pounds per square inch) of the stress upon the extreme fibers of a beam at the point where, and at the time when rupture begins.

The modulus of elasticity is the ratio of

$$\frac{\text{Unit stress (in pounds per square inch)}}{\text{Unit distortion (expressed as fractional part of length)}}$$

The elastic resilience of a beam is the product of one-half the load into the deflection at the loaded point. For a beam loaded with numerous concentrated loads the resilience is one-half the total sum of each load into the deflection of beam at that point. This quantity is a function of the volume of the beam.

Bill of material for Fig. 2.

TIMBER, EXCLUSIVE OF TIES AND GUARD RAIL.

Species.	Used for—	Size.	Number of feet B. M.	Cost per thousand.	Total cost.
Longleaf pine	Stringers	6 Pieces, 7¼″×15″×14′ in 14′ lengths	815	$11.00	$8.96
White oak	Caps	1 Piece, 9 ″× 9″×10′	68	11.00	.75
Red cypress	Posts	4 Pieces, 9 ″× 9″×13′	351	8.00	2.81
White oak	Sills	1 Piece, 9 ″×10″×15′	112	11.00	1.23
Longleaf pine	S. Braces	1 Piece, 9 ″× 7″×18′ 6″	76	8.00	.61
White oak	Corbels	6 Pieces, 7¼″× 9″×2′	58	8.00	.46
			1,480		$14.82
		Cost of iron			5.31
		Total cost of panel			$20.13

Bill of material for Fig. 3.

TIMBER, EXCLUSIVE OF TIES AND GUARD RAIL.

Species.	Used for—	Size.	Number feet, B. M.	Cost per thousand.	Total cost.
Longleaf pine	Stringers	8 pieces, 7¼″ × 14.5″ 14′ long	982	$10.50	$10.31
White oak	Caps	1 piece, 12″ × 12″ × 10′	120	11.00	1.32
Red cypress	Posts	4 pieces, 9″ × 9″ × 13′	351	8.00	2.81
White oak	Sills	1 piece, 9″ × 10″ × 15′	112	11.00	1.23
Longleaf pine	S. braces	1 piece, 7″ × 7″ × 18′ 6″	76	8.00	.61
			1,641		$16.28
		Cost of iron			3.17
		Total cost of panel			$19.45

Bill of Material.

TIMBER, EXCLUSIVE OF TIES AND GUARD RAIL.

Species.	Used for—	Size.	Number feet, B. M.	Cost per thousand.	Total cost.
Longleaf pine.	Stringers.	6 pieces, 8¼″ × 17″ × 14′ in 28′ lengths	982	$13.00	$12.80
Red cypress.	Caps.	1 piece, 12″ × 12″ × 10′.	120	11.00	1.32
Longleaf pine.	Posts.	4 pieces, 12″ × 12″ × 13′ 6″	648	8.00	5.18
Red cypress.	Sills.	1 piece, 12″ × 12″ × 16′ 3″	195	11.00	2.14
Longleaf pine.	S. braces.	1 piece, 8″ × 8″ × 19′	101	8.00	.81
			2,046		$22.25
		Cost of iron			2.86
		Total cost of panel			$25.11

Figs. 2 and 3 show designs recommended by the Forestry Division, that in Fig. 2 being preferred, though slightly more expensive than that in Fig. 3. These diagrams illustrate an

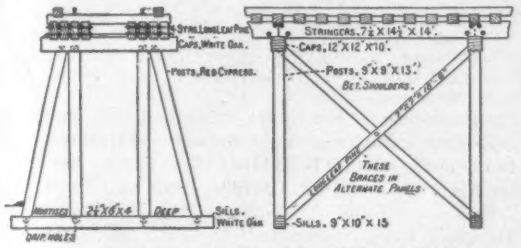

STRINGERS, 7½ X 14½ X 14'.
CAPS, 12' X 12' X 10'.
POSTS, 9' X 9' X 13'. BET. SHOULDERS.
THESE BRACED IN ALTERNATE PANELS
SILLS. 9" X 10" X 15
SILLS, WHITE OAK
POSTS, RED CYPRESS.
BRACES, 2½" X 6" X 6' DEEP

Fig. 3. Recommended Practice Without Corbels.

important point, *i. e.*, that the economical design of timber structures require the judicious employment of different species as well as different sizes in the same.

Recommended practice with corbels:

Factors of Safety.

Stringers in cross-breaking	5 +
Stringers in deflection, ⅓₀ span	2 +
Stringers in end bearing	4 +
Cap in bearing value	3 +
Posts in endwise crushing	7.4 +

Without corbels:

Factors of safety.

Stringers in cross-breaking	5 +
Stringers in deflection ⅓₀ span	2 +
Stringers in end bearing	3 +
Cap in bearing valve	3 +
Posts in endwise crushing	7.4 +

The designs in Figs. 2 and 3, though capable of carrying twice as much load as that shown in Fig. 1, show a saving of $5 per span, equal to 36 cents per linear foot of track and 28 per cent. less timber.

Assuming that this would be representative of one-half the total mileage of timber trestle bridges, *i. e.*, 1,000 miles, we have a total saving every nine years of $1,900,000, which is equal to an annual expenditure of $211,000. This capitalized at 4 per cent. gives a capital of $5,275,000. These 1,000 miles of trestle use annually about 120,000,000 feet, B. M., of valuable timber, 35,000,000 feet of which might readily be saved.

The tables of cost accompanying these designs upon which the above figures have been based are, of course, subject to great modification, depending upon the location, condition of the market, etc. It is thought, however, that they give a fair representation of the average conditions.

Advantages of Raising the Boiler and the Center of Gravity of Engines with a View of Obtaining an Increase in Power and Decrease in the Strain on the Permanent Way.*

The considerations put forward in the following seem to show successfully that the limits at present assigned to the power of express engines rest on somewhat imaginary bases and may be considerably extended. This splendid piece of machinery which has up till now met all requirements has not yet reached its final development and seems capable of meeting still further calls upon it in the future without the necessity of our having recourse to any special device or to new arrangements.

* Translated from the *Genie Civil* of Nov. 23, 1895 and appearing in the English edition of *Bulletin of the International Railway Congress*, for Feb. 1896.

The tendency toward keeping the center of gravity low which for a long time was prevalent among engine manufacturers has undoubtedly helped to retard development. The barrel of the boiler, cramped between the driving wheels could not be made larger; the firebox had no longer sufficient depth if in order to be prolonged backward, it had to be above a driving or coupled axle and this led to the following recognized disadvantages: imperfect combustion, excessive heating of the tube plates and leakage at the tubes. It was only since what may to-day be called a prejudice was renounced that we have been enabled, by making the boiler to a certain extent independent of the other parts, to place express engines in this respect on the same footing as engines with wheels of small diameter and so markedly to increase their power.

The example it must be acknowledged came from abroad. In England, they were already building what appeared to us very high engines when the Americans, who had till then remained faithful to the classical patterns, decided under the spur of necessity to raise the boilers of their engines right above the wheels and subsequently went much further in this direction than any European builder had dared to go. The highest of these engines (* hauled one of the fastest trains in the world day after day on lines with but slight superelevation and demonstrated that the utmost limit of stability had not yet been reached. The raising of the center of gravity of engines far beyond what would have been admitted as advisable a few years before was henceforth an accomplished fact and shown to be sound practice; the engineer could henceforth, without fear of trenching on the unknown, have recourse to a method which, while it allowed of engine steam power being increased, also presented special advantages.

The same object had been attained on both sides of the Atlantic by very different means. In England by far the larger proportion of express engines had wheels of large diameter as much as 7.7 feet (2.35 meters) for engines with single driving wheels (†) and internal cylinders. It was accordingly necessary to raise the boiler so as to leave room for the crank axle throws and the connecting rods and at the same time make the motion more easily accessible. In the United States, on the other hand, the cylinders were external and the driving wheels of small diameter. But the great weight of the trains necessitated powerful boilers and accordingly the latter had to be raised sufficiently to allow of the firebox frame being above the frame plate and the barrel of the boiler being above the driving and coupled wheels.

In the Crampton engine the axis of the barrel was situated 5.25 feet (1.605 meters) above the top of the rails, in the Orleans Company's external cylinder express locomotives it was 6.43 feet (1.96 meters), while in the Northern Railway's Outrance type it was 6.92 feet (2.12 meters). Later on this height was increased on some of the French lines and in most express engines recently built the axis of the boiler is between 7.21 feet and 7.47 feet (2.20 and 2.28 meters). We hear, it is true, of engines being designed in which the height is to reach 8.03 feet (2.45 meters). All express engines constructed in England during the last 12 years have been made with the axis of their boilers 7.44 feet (2.27 meters) high as a minimum; if the engines have internal cylinders and single driving wheels, the height usually reaches from 7.64 to 7.87 feet (2.33 to 2.40 meters), and exceptionally even 7.9 feet (2.41 meters) as in the North Eastern express engines. In Belgium, they have reached 7.77 feet (2.37 meters) and in Austria 8.2 feet (2.50 meters) in some engines actually being built. In the United States, the axis of the boiler barrel is at a height of 8.2 feet (2.50 meters) in the engines lately built and very often is as much as 8.52 feet, 8.69 feet (2.60 and 2.65 meters) and even reaches 8.95 feet (2.73 meters).

Some years ago, the New York Central Company adopted a type of express engine the boiler of which is situated just 8.85 feet (2.70 meters) above the rails.

The height nowadays regarded as a minimum in the United States is actually greater than the maximum in Europe.

Fig. 1, which shows diagrammatically on the same scale an express engine of a recognized and serviceable French type and one belonging to an American Company, gives a better idea than mere feet and inches of how far the Americans have gone beyond us in the power and height of their engines.

For comparison's sake, we have brought together in a single diagram Fig. 2 the front views of three classical types of engines: an old Crampton, an express Midland engine (England), and an engine belonging to the New York Central (United States). The English engine is no doubt, very high, but as the driving wheels are of great diameter (7.74 feet = 2.36 meters) the diameter of the barrel of the boiler is smaller than the distance between the tires. The New York Central engine is much higher, and the boiler reaches beyond the top of the driving wheels, the diameter of which is 7.08

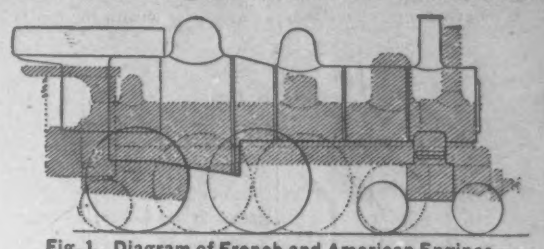


Fig. 1. Diagram of French and American Engines.

feet (2.16 meters). To allow of this engine running on our lines, we should have to cut off part of the chimney and the upper part of the dome. The top of the dome on the firebox is 12.3 feet (3.75 meters) above the rail.

Advantages from Raising the Center of Gravity.—In his work on the locomotive, published in 1877, Mr. Reynolds already stated that "of all express engines running at present the highest provide the greatest security." This assertion is doubtless not an axiom, but still it is in conformity with facts.

When the flanges of the wheels of a locomotive strike the rail on one side under the influence of centrifugal force at a curve, or of movements of oscillation, the engine gives the rail, everything else being equal, a jar which is all the more violent in proportion as its center of gravity is lower. If we suppose the center of gravity to be at the level of the rail, the strain due to the centrifugal force will be entirely transmitted to the rail; If the center of gravity were removed to an infinite distance above the permanent way, the engine would no longer have any stability, and under the influence of an infinitely slight contrifugal force would balance itself on the outer rail, without causing any appreciable strain tending towards displacement. In practice, every engine occupies an intermediate position between these two extreme conditions, but we can already draw the conclusion from the above that the higher an engine is the less will it tend to displace the permanent way. To make it absolutely safe, we

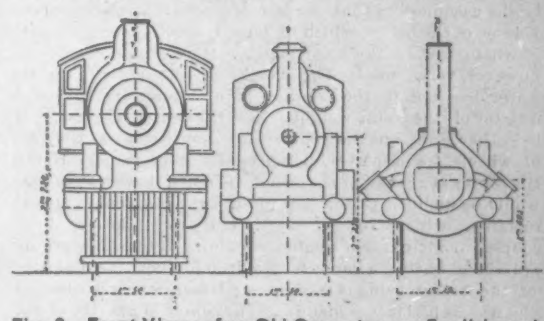


Fig. 2. Front Views of an Old Crampton, an English, and an American Engine.

shall only have to give it the minimum stability consistent with its running no risk of being upset when passing at full speed over curves of the smallest radius which will it have to pass. Now experience shows that this limit is not exceeded by the most lofty American engines.

In this way the more obliquely will it act upon the rail under the action of the transverse strains due to oscillation or centrifugal force. But—and this is the important point—as the engine is hung on springs, the higher its center of gravity the greater will be the proportion of its weight which will bear vertically on its outer wheels. This decreases the tendency toward derailment by loading the outer wheels more heavily and the tendency toward spreading of the gage by the extra weight on the outer rail. Moreover, as the springs come into play this action is felt gradually and without shock, while the strain due to centrifugal force when an engine possesses great stability acts suddenly and violently. The old Crampton engines displaced the permanent way, not so much on account of their long rigid wheel-base as because of their excessive stability.

The transverse movements of the engine on the road, due to oscillation or to centrifugal force, will react upon the flanges of the wheels, on the bearings, boxes and throws of the crank axle, and these reactions will be all the more severe and sudden in proportion as the center of gravity of the whole is lower. If the engine is very high it will roll more and its springs will come into play; at the same time it will not be so hard on the permanent way, and the wear and tear and the chance of the crank axles or boxes giving way will be appreciably less.

Advantages of Raising the Boiler.—In goods engines whose wheels are of small diameter, the barrel may be made of as large a diameter as required, with a view to obtain the necessary heating surface and volume of water; when the firebox is above the trailing axle, it still remains sufficiently low down to avoid the necessity of raising the whole boiler. Such is not the case with express engines, whose wheels are of larger diameter. If the barrel is not sufficiently raised, its diameter is limited to the distance between the tires of the wheels; moreover, if the trailing axle is coupled and goes beneath the firebox, the latter must be much flattened. For instance, with driving wheels 6.56 feet (2 meters) in diameter, if the axis of the boiler is 6.94 feet (2.10 meters) above the rails, the external diameter

(*) We allude to the *New York Central* four coupled engines which haul the *Empire State Express* at an actual speed of 51 miles (82 kilometers) an hour.

(†) This refers to engines with internal cylinders; with external cylinders, the diameter reaches 8.2 feet (2.50 meters).

of the barrel is limited to 4.26 feet (1.30 meters) when only the necessary play is left between the wheel flange and the boiler. If the axis of the boiler is 8.2 feet (2.50 meters) high the external diameter of the barrel may be increased to 4.92 feet (1.50 meters); if it be increased to 8.52 feet (2.60 meters), the diameter may be increased to 5.41 feet (1.65 meters), which seems more than sufficient for the most powerful express train.

Fig. 3 shows the back view of an American engine with 7.08 feet (2.16meters) wheels, in which the boiler is situated sufficiently high to enable its diameter to be greater than the gage of the line.

We have shown above that, at any rate within the limits

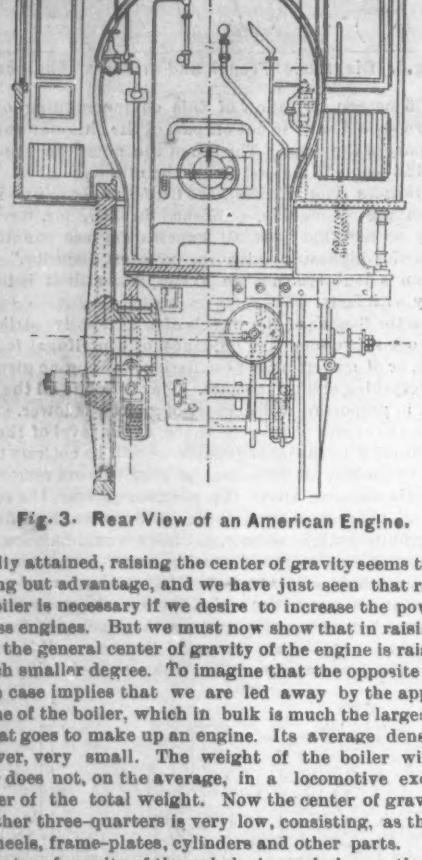


Fig. 3. Rear View of an American Engine.

actually attained, raising the center of gravity seems to offer nothing but advantage, and we have just seen that raising the boiler is necessary if we desire to increase the power of express engines. But we must now show that in raising the boiler the general center of gravity of the engine is raised to a much smaller degree. To imagine that the opposite might be the case implies that we are led away by the apparent volume of the boiler, which in bulk is much the largest part of what goes to make up an engine. Its average density is, however, very small. The weight of the boiler with its water does not, on the average, in a locomotive exceed a quarter of the total weight. Now the center of gravity of the other three-quarters is very low, consisting, as they do, of wheels, frame-plates, cylinders and other parts. Hence the center of gravity of the whole is much lower than one would be inclined to think at first sight, as the following instance will serve to show. Let us take a four-coupled bogie express engine, weighing 48 tons in working order, and having a boiler with a deep fire-box, the diameter of the barrel being 4.06 feet (1.24 meters), and that of the wheels 6.56 feet (2 meters). The center of gravity of the parts which carry the weight, make up the mechanism and weigh 36 tons would be about 3.21 feet (0.98 meter) above the rail; the center of gravity of the boiler full of water, weighing twelve tons, would be about .98 foot (0.30 meter) below the axis of the barrel. Accordingly, if the latter is situated 6.88 feet (2.10 meters) above the rails, the center of gravity of the whole will only be 3.74 feet (1.14 meters) above the upper surface of the rails. If the axis of the boiler be 8.2 feet (2.50 meters) above the rails, the center of gravity of the whole would be only 4.06 feet (1.24 meters) high. In other words, as might have been foreseen, in raising the boiler 1.31 foot (0.40 meters) we have only raised the center of gravity of the engine .32 foot (0.19 meter).

Thus in an engine which is higher than any running in Europe—the axis of the barrel being 8.2 feet (2.50 meters) above the rail—the center of gravity for the whole is only 4.06 feet (1.24 meters) high, which is *much lower than the height of the center of gravity of loaded wagons or of the ordinary passenger carriages and all the more of saloon carriages with high and heavy bodies.* There are running on main lines cars whose center of gravity is 4.92 feet (1.50 meters) or more above the rails; in order that the center of gravity of an engine corresponding fairly closely to the description given above, should be equally high, *the axis of the barrel would have to be* 10.62 *feet* (3.24 *meters*) *above the upper level of the rails,* which is much higher than anything yet reached in the latest American engines.

Conclusions.—From what has been said it seems that the following conclusions may without risk be drawn:

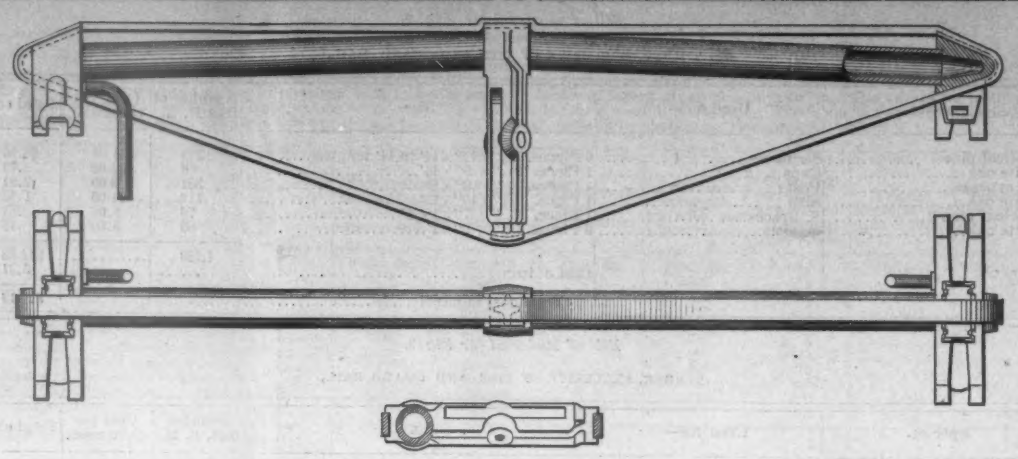
1. Within certain limits, which have so far not been reached in Europe, or even in America, raising the center of gravity of engines has nothing but good results. It results in decrease in the strain on the permanent way and on the parts which go to make up the engine, wheels, axles, boxes and frame plates. The running of the engines is made smoother because the springs come more into play under the action of lateral motion and in running round curves; the tendency to derailment is decreased by the increase of the load on the outer rail when curves are run over at a high rate of speed.

2. Raising the boiler seems to be the most practical, the most simple and the least costly method of increasing engine power, as it allows of the barrel having a diameter greater than the space between the tires.

3. As the boiler does not on the average make up more than about a quarter of the weight of an engine, if it be raised a given amount, the center of gravity of the whole is only raised about a quarter of this amount.

4. The center of gravity of the highest engines in use at present is much lower than that of passenger carriages and loaded wagons: it can therefore be considerably raised without fear of endangering safety.

What has been said above and the tendencies which from day to day become more marked, lead us to think that the future belongs to high engines, and that, cost what it may, we must endeavor to raise the boilers in order to make their power proportionate with the growing requirements of railway working, and with a view to decrease, in proportion as speed increases, the wear and tear on the permanent way.



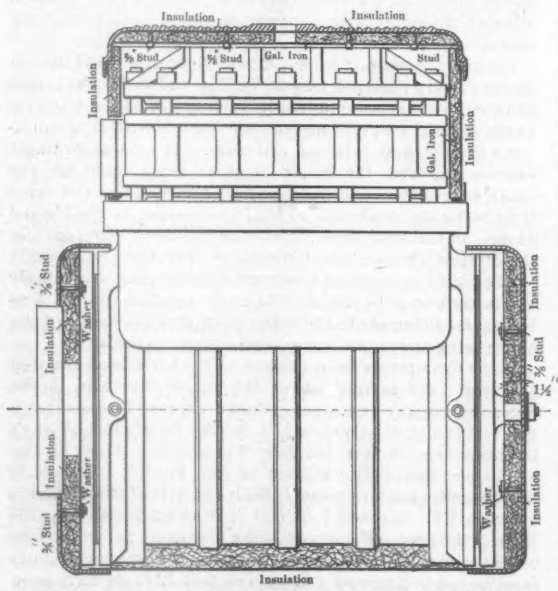
A New Brake-Beam.

A New Brake-Beam.

The accompanying illustration is a new brake-beam designed and patented by Mr. J. N. Barr, Superintendent of Motive Power of the Chicago, Milwaukee & St. Paul Railway. The compression member is of pipe and the tension member is a bar, rectangular in section, extending entirely around the compression member. The brake-heads are so made as to permit the tension member to be put on after it is formed into shape and welded. When heated and shrunk on it holds the heads firmly in place. The construction is exceedingly simple, and there is nothing about the beam to get out of order. It might possibly be argued that it could not be repaired on the road, but railroad men now appreciate the fact that metal beams should be repaired at the shops and not on the road. The beam is a few pounds heavier than some others because of the metal in the part of the truss back of the pipe, but that metal adds to the vertical stiffness of the beam, and is an advantage in that respect.

A Convenient Method of Jacketing Steam Chests and Cylinder Heads of Locomotives.

Many railroad men realize the advantage to be derived from thoroughly jacketing the steam chests and cylinder heads of locomotives, but this is seldom done because of the inconvenience the insulation causes when repairs are to be made, or the steam chest cover and cylinder heads removed for any reason. On the Chicago and Northwestern Railway engines are fitted with insulation in a manner which overcomes this objection, as will be evident from



Method of Jacketing Steam Chests and Cylinder Heads—Chicago & Northwestern Railway.

the accompanying illustration. The cylinder head casings have 1½ inches of insulating material (which we understand is asbestos) held to the inside of each by a disk of galvanized iron secured by studs screwed into the casing. Evidently when the casing is removed, the insulation comes with it, and the workman would not know of its presence except for the increased weight of the casing.

The steam chest casing cover is provided with insulating material, secured in place in the same manner. The vertical sides of the casing are made double and the inner and outer sheets flanged toward each other, with the flange of the outer sheet under the other. The space between them is filled with asbestos and when the casing cover is on it is secure. The insulation on the back cylinder head is not so easily removed as that on the front one, but there is seldom occasion to disturb it. This matter of thoroughly jacketing all parts of a locomotive to which the heat of live steam is communicated is worthy of careful attention, for the saving to be effected at small outlay is considerable.

Trade Catalogues.

[In 1894 the Master Car-Builders' Association, for convenience in the filing and preservation of pamphlets, catalogues, specifications, etc., adopted a number of standard sizes. These are given here in order that the size of the publications of this kind, which are noticed under this head, may be compared with the standards, and it may be known whether they conform thereto.

It seems very desirable that all trade catalogues published should conform to the standard sizes adopted by the Master Car Builders' Association, and therefore in noticing catalogues hereafter it will be stated in brackets whether they are or are not of one of the standard sizes.]

STANDARDS.

For postal-card circulars	3¾ inches by 6¼ inches.
Pamphlets and trade catalogues	3½ inches by 6 inches. 6 inches by 9 inches. 9 inches by 12 inches.
Specifications and letter-paper	8¼ inches by 10¾ inches.

Lead Lined Iron Pipe Company. *Manufacturers of Standard Lead Lined Iron Pipe and Fittings.* Wakefield, Mass. Price list No. 16. 16 pages. 5½ by 8½. (Not standard size.)

This company manufactures wrought-iron pipes which are lined with lead, the latter intended to resist corrosion, and the outside iron casing giving the requisite strength to resist internal pressure. Lining a pipe with lead is not very difficult, but the company makes all the fittings, couplings, elbows, tees, etc., which are also lead lined, and in such a way that part of the thread for screwing the parts together is cut in the lead and part in the iron. Cuts are given showing sections of the pipes and fittings, with tables of their dimensions.

The Thompson-Ryan Direct Current Multipolar Electric Generator. *Built by J. H. McEwen Manufacturing Company.* Havemeyer Building, New York. Works: Ridgeway, Pa. 32 pages, 5¾ by 8¾ inches. (Not standard size.)

The frontispiece of this pamphlet is a half-tone engraving made from a wash drawing of the works at Ridgeway, Pa. In the introduction it is said that the company has made arrangements with Prof. Harris J. Ryan, of Cornell University, and Milton E. Thompson, the inventors of the Thompson-Ryan dynamo, for its manufacture. This, it is said, "is replete with novelties," but "has long since passed the experimental stage, as is fully attested by a number of large sized machines now in constant operation under the most trying conditions." They then proceed to give a full description of these machines, and also add interior views of the works where they are made. Following, then, are half-tone illustrations showing generators driven by horizontal direct connected simple and compound and also vertical engines. The details of the generator are also fully explained and some of them illustrated with very excellent half-tone engravings. The full-page engravings all have ornamented borders, which, with the letter-press, are printed in brown ink, the engravings being black. The paper and typography are all of the best.

Illustrated Catalogue and Price List of the Boston Gear Works, 31 Hartford street, Boston, Mass. 40 pages, 5½ by 8 inches. (Not standard size.)

In this little pamphlet the publishers describe various kinds of small gears suitable for clock-work and very light machinery, and which doubtless will be useful to many of our readers, who, like ourselves, have often not known where such gears could be obtained. The different sizes, styles, etc., are illustrated and described by cuts and tables. "Intermittent gears," universal joint couplings brass ratchets and pawls, miter bevel, crown, internal, elliptical and spiral gears, escape wheels, clutches, keys, small pulleys and hangers, chains and chain-wheels, cotton worms and worm-gears, are all manufactured by this company and are described in the pamphlet before us. The company also manufacture gears for heavy machinery, but these, it is said, will be described in another catalogue.

No. 55, Price List, Galvenized Steel Wire Nettings, Wire Fencing. Wire Window and Door Screens, Etc. *De Witt Wire Cloth Company,* 17 Warren Street, New York. 28 pages. 3½ by 6 inches. (Standard size.)

This company manufactures steel wire netting for various purposes, cable for lightning rods, and fencing wire and ribbon fencing, wire window and door screens, etc., all of which are illustrated and described in the little volume before us the only fault of which is that it is printed in blue ink.

Morris Machine Works. *Builders of Centrifugal Pumping Machinery, Engines and Boilers,* Baldwinsville, N. Y. 32 pages. 6 by 9 inches. (Standard size.)

In the introduction to this catalogue the publishers say that "centrifugal pumps are constantly finding new favor

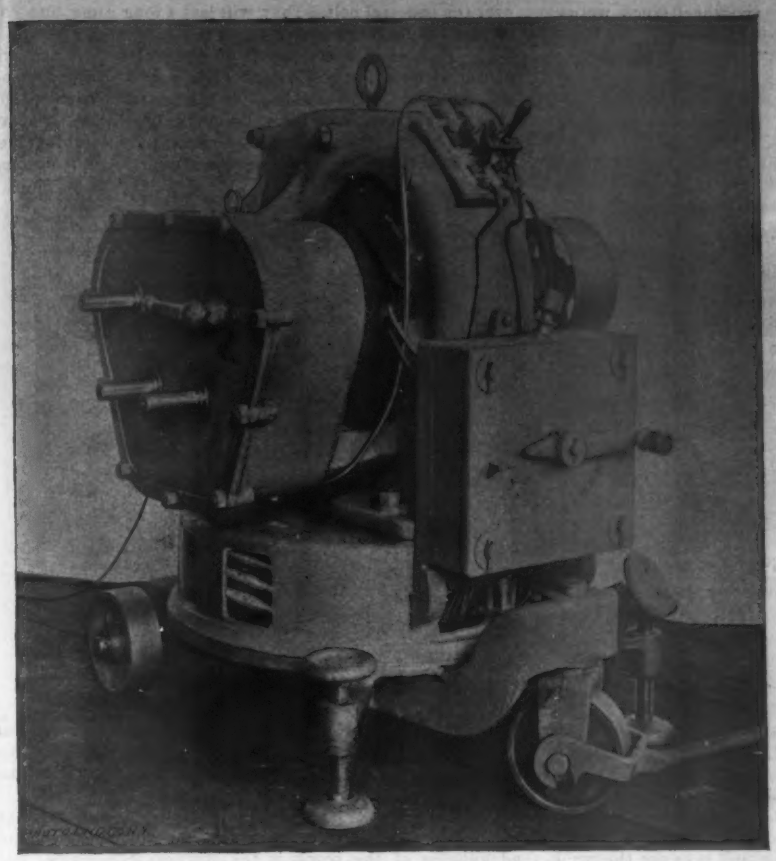


Fig. 1.

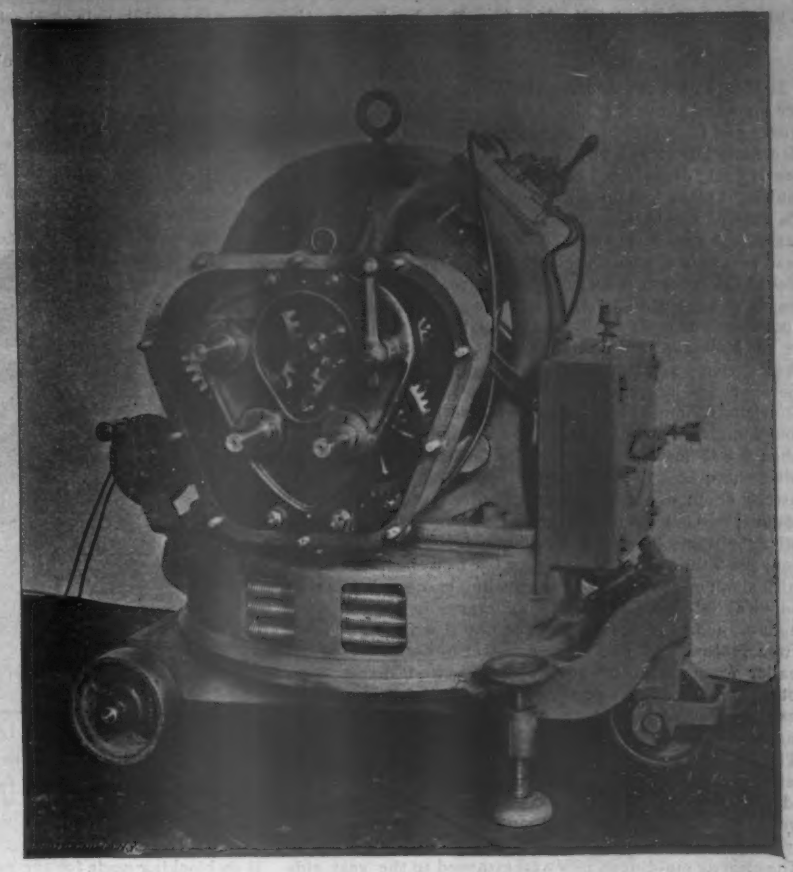


Fig. 2.

GIBBS' PORTABLE ELECTRIC MOTOR FOR SHOP USE.

from users, on account of their simplicity, durability, great capacity for handling material in large quantities, capability of pumping muddy and gritty water (which would shortly cut out any piston pump), their great economy of power under low lift and their low cost, which is anywhere from one-third to one-half that of any other type of pump."

In a following article the advantage of having a pump properly proportioned to the work which it must do is set forth and explained. Illustrations are then given of a large sewage pump with a direct connected engine, which is followed by an illustration and description of the different sizes of vertical pumps that is there, the shaft of which is in a vertical position. Several types of pumps, to be driven by belts, are then illustrated and described, and tables of drums of the different sizes are also given. This is followed by a curious diagram showing the position of the suction and discharge pipes of various patterns of pumps, 32 in all. It would hardly seem possible to place these pipes in so many different positions.

A number of illustrations follow, representing direct connected pumps, in which vertical engines are connected direct to the pump shaft. Several hydraulic dredging pumps to be driven by belts, and a portable pumping outfit and various details of these machines are shown.

The wood engravings are all excellent and the typography equally so, and the whole makes a very attractive volume.

The Gibbs Portable Electric Motor for Machine Shop and Round-House Work.

In shops where electricity is used for lighting and power purposes, portable electric motors can be used to advantage in the same lines of work that steam and compressed air motors are so frequently employed. In many situations they present superior advantages, because of the ease with which they can be connected to receive power, flexible wire cables taking the place of iron pipes for steam or air, and from the fact that there is no exhaust to be taken care of.

The Gibbs Electric Company, of Milwaukee, Wis., has recently designed and built a number of portable motors for general machine shop work, from photographs of which the accompanying illustrations were made. It is the intention to use these motors with Stow or other flexible shafts for such work as boring cylinders, facing valve seats, drilling staybolts, tapping sheets for staybolts, and general round-house and machine shop work, in which motors can take the place of man power with economy.

Figs. 1 and 2 are both rear views of the motor mounted on a three-wheeled track, Fig. 1 showing it complete, while in Fig. 2 the cover of the spindle case is removed. The commutator is on the further end of the armature shaft, and the pulley adjacent to it, which can be seen in Fig 1, is used for belting direct to machine tools. Fig. 2, which is taken from a slightly different position, shows at the left a cable reel, on which is wound about 100 ft. of cable, allowing the motor to be moved within a radius of about 100 ft. from the supply of current. On the end of the cable is a plug, which can be inserted into sockets at various points in the shop, so that the tools can be taken anywhere and receive power.

The motor is mounted on a round base, which in turn is mounted on the truck proper on a center pin. The round base is in the form of a turn-table, so that the motor can be swung around to suit the work. In this round base is placed the resistance coils, which vary the speed of the motor.

The box, or gear case, containing the drill spindles, is shown in both illustrations, Fig. 2 having the cover removed to show the gearing. The three spindles run at 177, 98 and 40 revolutions respectively. These speeds can, of course, be changed to suit any requirements which it may be necessary to meet. It may be noticed that there is a handle on the spindle box, similar to that used on the back gearing of lathes. When it is desired to use the pulley only, the gearing is by means of this handle thrown out of clutch, and the wear on the same is avoided.

On the right hand side, in both of our figures, is shown the main switch and controlling box with reversing switch. The reversing switch lever is seen projecting through the top of the box, and is interlocked with the controlling lever, so that it is impossible to reverse the motor unless it is first stopped. The resistance coils in the base will vary the speed of the motor from 900 to about 450 revolutions per minute, thus, of course, reducing the speed of the spindles proportionately.

When at work the motor is steadied by the two screws bearing on the floor, and the handle for hauling it about the shop can be taken off so as to be out of the way.

Everything about the motor is made on jigs and templets and is interchangeable. The gearing is the best obtainable. All the spindle bearings are exceedingly large, and, as the gears run in oil, perfect lubrication is obtained. The motor is five horse-power, and is sufficiently large to drive any ordinary machine tool found in railroad shops. The spindle running at 177 revolutions is intended for tapping in staybolts, and it has been found that it is possible to run staybolt taps at this speed. The other two speeds are for cylinder boring and valve-seat facing. If it is desired to use the spindles for running-rope drives, a pulley can be put on any one of them, the advantage of this being that the spindles are so reduced in speed that no countershaft is necessary.

The weight of this motor complete is 1,400 pounds, but, on account of its construction, is readily moved about the shop by one man. Everything about the motor, gearing and truck is of the best, and no expense has been spared in making the tool as perfect as possible.

The Becker Vertical-Spindle Milling Machine.

In the accompanying illustration we show an interesting vertical-spindle milling machine made by the John Becker Manufacturing Company, of Fitchburg, Mass. It is claimed for this machine, which is known as No. 5, that it is more practical, is of greater adaptability and has more labor-saving qualities than any horizontal spindle mill on the market. As a boring mill it is in many respects superior to the drill press.

The frame is heavy and very rigid, and is therefore suitable for heavy cuts. The spindle has long bearings running in bronze boxes that are adjustable for wear. The lower end of it is threaded for chucks or large face mills. The shanks of end mills are secured by the drawbar which passes through the center of the spindle. To get rid of end play, the lower bearing is provided with ball thrust bearings at both ends, thus reducing friction and securing a level surface when using face mills. The driving pulley of the spindle is 15 inches diameter and 3¾ inches face, and double back-geared 5 to 1. It is independently mounted to secure the permanent alignment of the spindle. This is a valuable feature on a vertical spindle milling machine, as without it the spindle is eventually worn out of alignment, impairing the general usefulness of the machine, by making the use of large surface mills impracticable, for obvious reasons.

The head has a vertical traverse of seven inches automatically and with automatic release. It is provided with a stop gage graduated to thousandth of an inch.

The knee has a vertical adjustment of 18 inches, and the greatest possible distance between table and spindle is 21 inches. The table is 48 by 13 inches (working surface), and has an automatic feed of 40 inches. The saddle, which is the same length as the table, has a cross feed of 13 inches. The

The Becker Milling Machine.

rotary attachment, with an automatic feed in either direction, is found to be an exceedingly useful feature. The table is 22 inches in diameter and will swing work 34 inches.

The table has six changes of straight and rotary feed for each change in speed. An arbor support, attached to the knee, is provided for use with long arbors for slab or straddle milling. Gripping jaws, 9 inches by 2 inches, fitting the slots in the table, also accompany the machine.

The workmanship and materials are guaranteed to be of the best and no pains are spared to make it a reliable and accurate machine. A glance at the illustration shows it to be a handy and convenient tool for many kinds of work. In drilling and boring work it has a large range and the rotary feed makes it possible to mill out large holes with great accuracy. The machine complete with countershaft weighs about 4,300 pounds.

The success of this tool has been remarkable not only in this country but also abroad. A firm in Budapest, Hungary, are using two of them and has just ordered a third.

The Use of Electricity in the Brooks Locomotive Works.

In 1881 the Brooks Locomotive Works purchased two five-arc light and three 10-arc light dynamos for illuminating its works and from the small beginning thus made, the use of electricity has spread until it is used for light and power in nearly every department of the plant. In 1888 an incandescent light plant was installed, but it was not until 1892 that the current was used for power purposes. Then two power generators were put in service to furnish current for overhead cranes in the boiler shop and foundry, and in 1894 the uses of the current, actual or prospective, were so numerous that it was decided to concentrate the generating plant and a contract was made with the Western Electric Company, for one 200-horse power and one 100-horse power generator. These generators supplanted all other apparatus and now operate 80 arc lamps, 450 incandescent lamps, and furnish electricity for one 35-horse power motor to run shafting in iron foundry; one 30-horse power motor for transfer table; one 25-horse power motor for the bending rolls in the boiler shop; one 10-horse power motor for the shafting in pattern shop; one 6-horse power motor for elevator in iron foundry; two 5-horse power motors for punch and shears in boiler shop; one 40-horse power motor for shafting in boiler shop; one 21-horse power motor for bar iron shears, in blacksmith shop; one 20-ton electric traveling crane in boiler shop and two 10-ton electric traveling cranes in foundry. The larger crane in the boiler shop is equipped with two 20-horse power motors and one 6-horse power motor, and the two smaller cranes are each equipped with two 10-horse power motors and one 6-horse power. There are eight electric motors connected with the foundry; six on the cranes, one running the shafting and fans, and one running the elevator.

The two generators furnish power for all motors, driving shafting and isolated machine tools, also current for all arc and incandescent lamps now in service. The arc lights throughout the plant are wired four in series, thus enabling any group of four lamps to be operated at will.

The electric building is new and attached to the east side of the boiler house. Upon entering it, the first thought is of its spaciousness, neatness and order. It has a granalithic floor and the conduits are covered by iron. The two generators, one 200 horse power and the other 100 horse power, are driven by two Buckeye engines directly connected. The steam pipes are all covered with asbestos and jacketed with Russia iron, with polished brass bands. From the generators the current is conducted through lead-covered cables to a large switch board, through a conduit of brick laid in Portland cement, and covered with cast-iron plates, laid in cement, which renders the conduit water light. From the switch board the current is distributed throughout the works.

Use of Compressed Air.

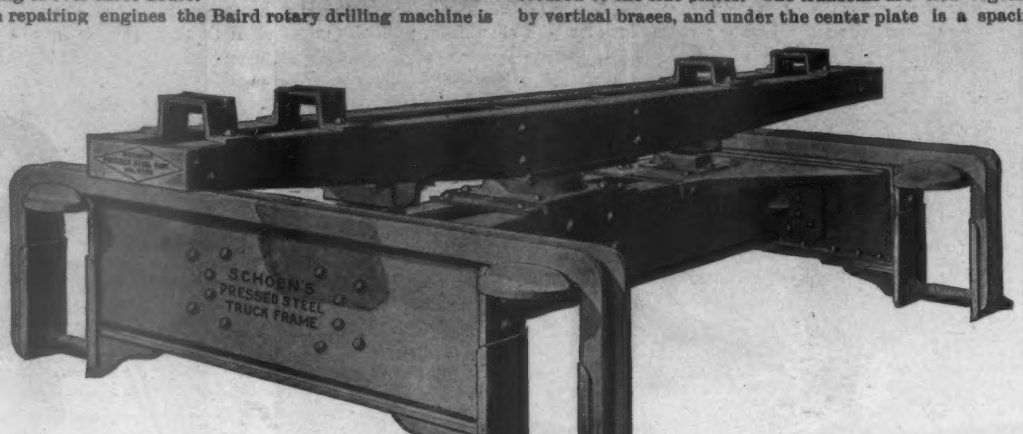
The repair shop of the Atchison, Topeka & Santa Fe at Argentine, Kan., has been fitted up very extensively with pneumatic tools. In the passenger car department the broom and duster and the rattan beater have been thrown away, and the cars are cleaned by the use of compressed air, which is piped through the yard. The laborer simply attaches a hose and turns on the air, and the cars are cleaned much more thoroughly than broom er duster can do it, as the air gets behind every steam pipe and all blinds and ventilators, where it would be impossible to clean by other means. The medical department regards the system the greatest microbe destroyer known.

By the same power wheels are taken from under coaches with a pneumatic jack, a drop pit being used, into which the wheels are dropped. Only the weight of the wheels is handled, instead of the weight of the whole car. At a recent test the middle pair of wheels in a six-wheel truck were exchanged in five minutes and twenty seconds. By the old method this exchange would have required at least two hours' time.

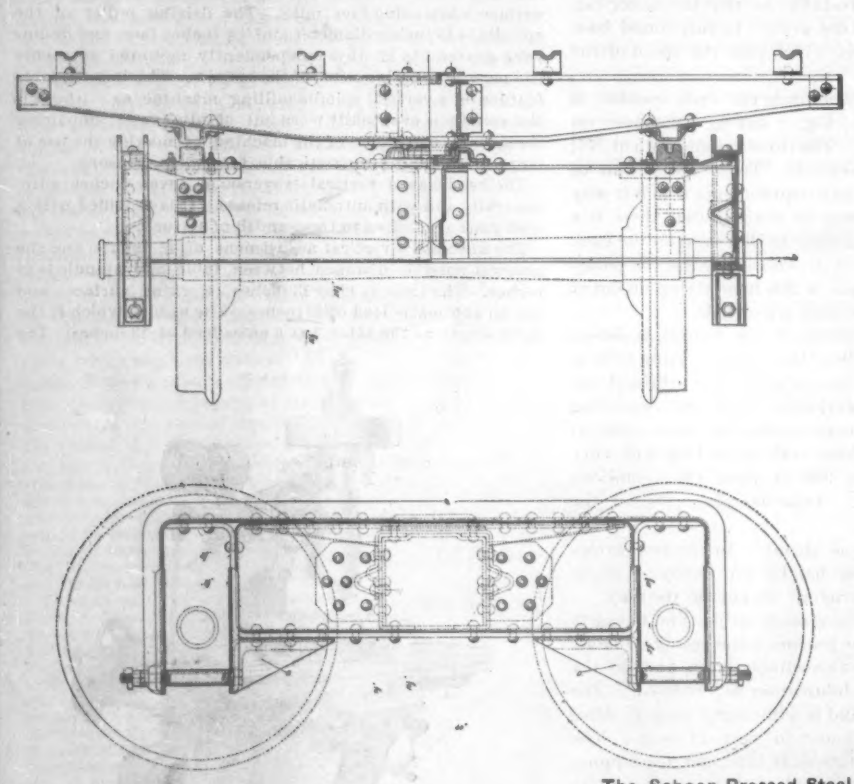
In the round house wheels are taken from locomotives in the same manner, in from thirty to forty-five minutes, a saving of over three hours.

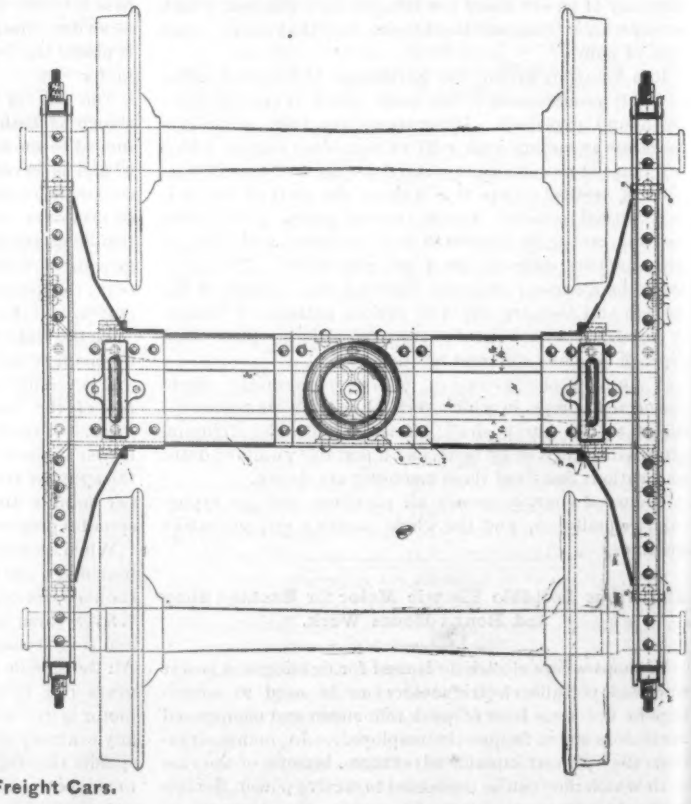
In repairing engines the Baird rotary drilling machine is used, which is worked by the same power. Holes are tapped in a firebox by this method, and flues are rolled and caulked, using a pneumatic hammer which strikes 250 blows a minute, thus doing what was always thought to be impossible—clipping and caulking by other than hand labor. It is but the work of an instant to jack up a freight car, set it on blocking made for the purpose, and take out the truck for repairs. Air pipes are bent in standard shapes by use of air cylinders and dies. Car roofs are torn off by air machines, and car sills are pulled down by an air jack and new ones put back by the same power.

A simple means of delivering oil is in use in the yards. A reservoir close to the oil house is filled with oil, which is forced through underground pipes to any oiling station in the yard in an instant. The pipe is nearly a mile long.—*The Southwest Railway Record.*



The Schoen Pressed Steel Trucks for Freight Cars.





The Schoen Pressed Steel Truck for Freight Cars.

The Schoen Pressed Steel Truck for Freight Cars.

To meet the demand for a more substantial freight car truck, the Schoen pressed Steel Company, of Pittsburg, has brought out a pressed steel truck, shown in outline and prospective in the accompanying illustrations.

The designer started out with the decision to put the springs over the journal boxes, and to make a truck that, besides being reasonable in first cost, will be inexpensive to maintain. The side frame is composed of a top compression member in the form of an inverted channel and a bottom tension member consisting of a bar of 4 by ⅝ inches iron. Between these there is a pressed steel plate with all of its edges flanged inwardly. These flanges supplement the strength of the compression and tension members. The parts are riveted together with hydraulic power.

The ends of the compression members are turned down to form the outer jaws of the pedestals, and the inner jaw is riveted into place as shown. At the bottom they are held in proper relation to each other by a thimble and heavy bolt provided with two nuts and a split key. The faces of the jaws are protected against wear from the journal boxes by chafing plates. These are thin and light and have a rectangular hole near the bottom which permits them to be fitted over the pedestal bolt. They will last a long time and can be renewed for a few cents.

The transoms are composed of channel-shaped sections placed with the flanges toward each other. They rest on top of the lower flange of the side plates and have their ends stamped outwardly to form brackets by which they are secured to the side plates. The transoms are tied together by vertical braces, and under the center plate is a spacing plate that greatly aids them in resisting transverse strains. To keep the truck square gusset plates extend from the inner jaws of the pedestals to points well out on the transoms.

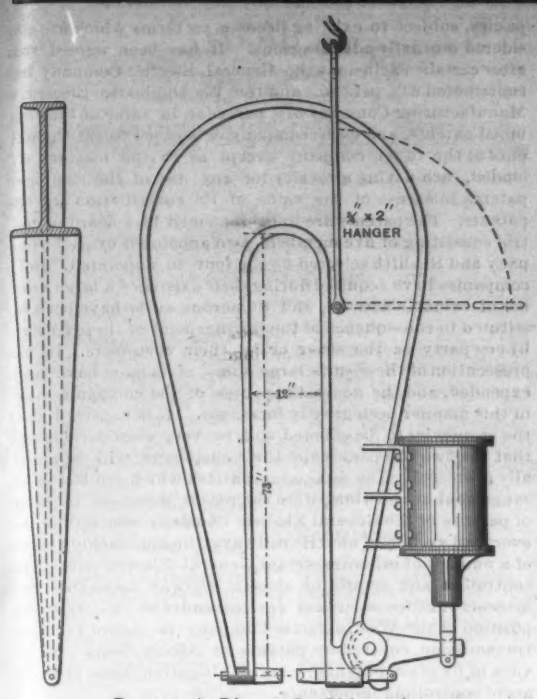
The body bolster shown should really be considered as inseparable from the metal truck, for one of the several advantages of the truck is the stiffness obtainable; but this freedom from deflection, unattainable with a wooden truck bolster, will not keep side bearings entirely out of contact unless there is used in connection with the truck an unyielding body bolster.

There are several advantages for making the side frame of several pieces instead of a single one. In the first place the top and bottom chords of the truss need not be made of the same thickness as the plate, but can be of such sizes and sections as are requisite for strength independently of any considerations of the size or weight of the plate itself. It also facilitates the construction of the pedestals in a substantial but inexpensive manner. Again, it makes it possible to repair the frame in a railroad shop if it has been distorted in an accident, and does not necessitate re-forming the whole side in the original dies with the attendant delays and freight charges.

A few of the claims made for this design are: Increased car mileage; a saving in dead weight; a saving in flange wear on wheels and wear on rails because the truck is kept square; repairs can be made in the railroad shops; a reduction of cost of repairs to a minimum; and the avoidance of such hot boxes as are caused by frames getting out of square. The material is a special grade of mild steel, which the extensive experience of the Schoen Pressed Steel Company has shown to be best adapted for work of this character.

A Pneumatic Riveter for Shipyards.

The Baird Portable Machine Company of Topeka, Kan., are known to many of our readers through the various pneumatic tools built by them and specially adapted for use in railroad shops. But the demand for pneumatic



Pneumatic Riveter for Shipyards.

riveters, punches, etc., is not confined to railroad circles, for the company has just furnished the Chicago Ship Building Company the large riveting machine which we illustrate in the accompanying engraving. It has a 73-inch throat and a 12-inch gap, and has been designed especially for shipyard work.

The air cylinder is about 12 inches in diameter and is mounted on a shelf cast on the frame. It operates through a bell-crank lever fulcrumed on the frame. Instead of pin connections at the ends of the lever, these ends bottom in jaws in the piston rod and riveting plunger, and are held in position during the return stroke by comparatively small pins inserted in the jaws outside of the lever.

The machine is suspended by a hanger, on which it is so balanced as to be easily worked in either the vertical or horizontal positions, or at intermediate angles. This is only one example of the special tools which this company has furnished or is prepared to build for parties whose work is of such a character as to require them.

The Q. & C. Perfection Oil Purifier.

The Q. & C. Company, of Chicago, has recently added to its line of specialties the oil purifier which we show in the accompanying sectional engraving. It consists of a cylindrical casing having a short, open-top cylinder inside of it rivited to the bottom, and a large pan placed inside the casing, and having a central tube extending down from it into the cylindrical shaped vessel at the bottom. This tube carries a bell-shaped vessel which covers the cylindrical one, but without touching it at any point. A cover on top of the casing closes the apparatus. Two gage glasses *A B* and *C D* are provided, also a steam coil which takes steam at 5, a steam pipe with an admission valve 4, and faucets 1, 2, 3 and 6.

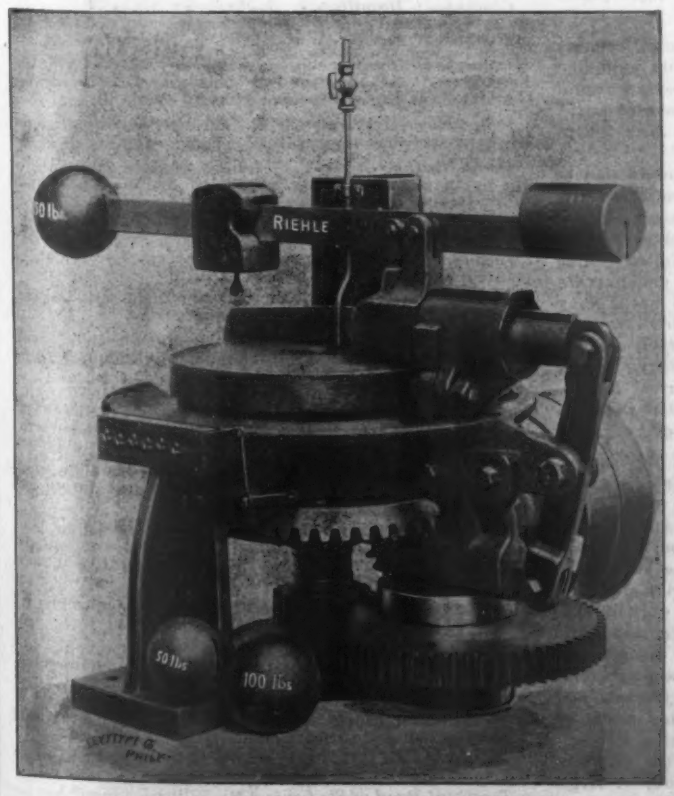
The operation of the purifier is as follows: Water is poured into the upper pan until it rises to within two inches of the top of the lower glass, which point is indicated by the words "water line" in our illustration. Steam is then turned on at valves 4 and 5 until the temperature of the water rises to about 115 or 120 degrees, after which valve 4 is closed and valve 5 regulated to maintain that temperature. Oil to be cleaned is then poured into the pan slowly, and as it descends it is heated and thereby thinned and made to give up much of its impunities, the process of purifying being completed by its passage through the water. Its course is to pass down through the central tube into the water, through which it rises, and then, passing over the top of the cylindrical vessel, goes down between it and the bell-shaped vessel; from thence it is liberated through perforations in the lower flange of the bell and rises through the water a second time to collect on top of it and be drawn off through faucets 6 or 8. In practice the purified oil is kept at about the height shown

The Q & C Perfection Oil Purifier.

in our illustration and when any great quantity is drawn off oil to be cleaned is fed into the pan to take its place.

The purifier does not require cleaning oftener than once in six to twelve months. To clean it, faucet 6 is opened and all the clean oil drawn off, water being poured into the apparatus at the pan to make all of the oil rise to that faucet. Then a full head of steam is turned on at valve 4 and the dirty oil and water will rush out of faucets 1 and 2 when they are opened.

The purifiers have been used long enough to be heartily endorsed by many concerns that have them in service at their shops. They are simple and inexpensive, easily operated, and use a washing medium that does not clog up or waste any of the oil. Only one caution is given, which is to be careful not to overheat the oil, as too much heat makes it thick and spoils it. The purifiers work equally well with all grades of oil and effect a great saving. They are made in 25, 50, 80, 100, 150, 225 and 300 gallon sizes, which have a filtering capacity every 24 hours of 1½, 3, 5, 8, 10, 15 and 20 gallons respectively. From these figures it will be seen that besides acting as filters they afford a large storage capacity. Any special sizes wanted can be furnished at short notice. Further information will be supplied by the Q. & C. Company, Western Union Building, Chicago, Ill.



Riehle Abrasion Testing Machine.

Riehle Abrasion Testing Machine.

The Riehle abrasion testing machine, shown herewith, is an apparatus 25 inches high, 29 inches wide, 34 inches long, and weighs about 350 pounds. It is arranged to take specimens of 1-inch cube or smaller, and can be arranged to take 2-inch cubes also.

The apparatus consists of a revolving disk on a vertical spindle. It is geared three to one, and the disk is fitted with a hardened steel grinding plate. Above this plate a horizontal arm is arranged capable of sliding backward and forward and carrying at one end a 1-inch cube, or other shape, to be subjected to abrasion. This arm also carries a weighted lever or graduated beam capable of loading the abrasion specimen as high as 200 pounds. The spindle of machine is made to revolve by the bevel gears and 10-inch pulleys, as shown, and an extra pair of gears of unequal size give motion by cam and pin to the lever arm, which moves the horizontal arm backward and forward over the grinding disk. The apparatus is also furnished with revolution counter for indicating number of revolutions during test, and with a sandbox and water duct for furnishing grinding material. A brush or scraper may be used to clean the disk if desired. It is intended to run the pulleys at about 150 to 175 revolutions, giving 50 or more revolutions of the grinding disk. It is also intended that the lateral movement combined with the revolution will distribute the wear uniformly over a large part of the surface of the disk. The flange of the main frame is arranged to protect the gearing, and a spout at one part carries off surplus sand and water.

The machine was made for the Cambria Iron Company, and is in use by them at Johnstown, Pa. It was built by Riehle Brothers, Philadelphia, Pa.

The Dickerman Twenty-inch Tool Grinder.

The accompanying illustration shows a new 20-inch tool grinder made by the Dickerman Emery Wheel and Machine Company, of Bridgeport, Conn. It is neat and substantial in design, convenient for the operator and confines the water to the right place. The water pan may be quickly drawn through the door in front of the base when it is necessary to clean it, then be placed back in machine and refilled by pouring fresh water into the table, where it will run down into the pan below. The round table in front of the wheel permits the operator to always be at the same convenient distance from the emery wheel, in whatever position he wishes to hold the tool when grinding.

The hood is in one piece except the front, which with the tool rest is adjustable to the wear of the wheel. The emery wheel being encased and with this company's special device inside the hood, water and spray are kept from the emery wheel collars, bearings and floor, and the interior arrangement of the machine is such that no water can get on the floor, inside of the base.

The emery wheel collars are dovetailed and fitted with a device for balancing the wheel. These collars and all other running parts of the machine are turned inside and out, and dust collars are used to keep all water and dirt from

The Dickerman 20-Inch Tool Grinder.

the bearings. This machine being equipped with long self-oiling bearings and a large spindle runs very smoothly. The wheel is 20 inches diameter and 2½ inches or 3 inches face. The diameter of the spindle is 2 inches; the boxes are each 6½ inches long, the spindle pulley 6 inches in diameter and 3½ inches face; the height from the floor to the center of spindle is 36 inches; the foot of base is 20 by 30 inches, and the total floor space occupied is 28 by 35 inches.

Lidgerwood Cableways for the Panama Canal.

Spencer Miller, M. E., engineer of the department of hoisting and conveying machinery of the Lidgerwood Manufacturing Company, New York City, who recently went abroad in the interests of that company, has just closed a contract with the Compagnie Nouvelle Du Canal De Panama at Paris, for seven Lidgerwood cableways, to be used on the Panama Canal. This company is one which has recently been formed to complete the great Panama Canal, and the seven cableways will be used exclusively for earth excavating. They will be equipped with all the latest improvements, including the patent aerial dump, which is such an important feature of these machines, the apparatus throughout being similar in construction to the 20 Lidgerwood cableways used on the Chicago Main Drainage Canal, except that the Panama cableways will have fixed towers and anchorages. The spans will range from 250 to 300 feet.

This order was not placed until after a most careful and extended investigation had been made of the various apparatus available for canal excavating purposes. Engineers were sent by the Compagnie Nouvelle Du Canal De Panama from Paris to examine the Lidgerwood cableways and other excavating machinery in use at Chicago on the canal there building. The result of their investigation was a most flattering report in favor of the Lidgerwood cableways, and the negotiations then begun have resulted in the large order secured by Mr. Miller. This is one of the largest single orders for cableways of any description ever received by any concern in this country from abroad, and points to a world-wide appreciation of the merits of the Lidgerwood cableway.

The Gates Iron Works announce the removal of the down-town office at Chicago to 1112 Masonic Temple.

The general offices of Fairbanks, Morse & Co. in Chicago will, on May 1st, be moved to the northeast corner of Monroe and Franklin streets.

The Chicago office of the Schoen Manufacturing Company, of Pittsburgh, has been moved from the fifth floor to Room 1016 of the Monadnock Block.

The Eastman Fruit Dispatch Company has been organized, with $300,000 capital stock, to manufacture, build, equip, operate, lease and heat refrigerator cars, etc. The general offices are at Jersey City.

The general offices of the United States Metallic Packing Company have been removed to their works, 427 North Thirteenth street, Philadelphia, Pa., and all communications to the company should be addressed to that place.

The United States Wind Engine & Pump Company has sold to the Buffalo & St. Mary's railway two water stations, the tanks for which will be of 60,000 gallons capacity, and will be supported on steel trestles 60 feet high. The wind mills will be each 30 feet in diameter.

The Sterlingworth Supply Company, of 256 Broadway, New York, is erecting a manufacturing plant at Easton, Pa., which it expects to have completed April 1. In the new works there will be ample facilities for the manufacture of the company's various specialties.

The Crane Company, Chicago, has secured the right to manufacture and sell the Mason train signal and Mr. Harry R. Mason, the inventor of the system, has entered the employ of the company. An order has just been obtained to equip 25 engines and 80 cars of the Mexican National Railway with this signal.

The New York Equipment Company, of 80 Broadway, N. Y., is erecting buildings at Dunkirk, Ind., for a large locomotive and car repair shop, and is now in the market for the steam plant and the iron and wood-working machinery requisite for the shop. The plant will be large and complete and the machinery contracts will be large.

The Ontario Car & Truck Company, recently incorporated at Oswego, N. Y., has purchased a site in that place, 125 by 496 feet, and will there erect a large modern plant. The concern will manufacture cars, trucks, ventilators, heaters, seats and brakes. The company possesses a number of patents Its capital stock is $300,000, of which $100,000 has been paid in

During one week the Chicago Pneumatic Tool Company recently received orders by mail for two pneumatic hammers from France, three from Russia, four from New Zealand, four from Australia, and one from Austria, besides shipping 10 to London. An additional order of 11 hammers to London received later makes a total of 73 shipped to that city since Dec. 15, 1895.

J. S. Mundy, Newark, N. J., has ready for distribution a pocket edition of his very complete catalogue of hoisting engines, steam boilers, etc. The book is copiously illustrated and contains over 70 pages. It is just the right size to carry in one's pocket without being in the least bulky or in the way. Copies, will be forwarded to engineers, contractors and others interested upon application, mentioning this paper.

The Pennsylvania Iron Works Company has recently determined to extend its business by going into the field of hydraulic engineering, and to that end has secured the services of Mr. Ernest W. Naylor, and purchased the rights and privileges of all patents, patterns, etc., owned by him. The company is in a position to enter this new field upon a good basis and any inquiries addressed to it will receive prompt consideration.

The Diamond Machine Company, of Providence, R. I., have just perfected a new and improved machine for grinding cotton mill spindles from the forging. The machine is a combination of their Universal and knife grinders with the necessary attachments for grinding the spindles to the proper taper. The machine gives perfect satisfaction, and although but recently completed orders have been placed by several manufacturers of spindles.

Watson & Stillman have received an order for the building of 15 draw benches for bicycle tube manufacture, each of them with a stroke of 18 feet.

This firm has also for some little time been at work upon a lot of hydraulic machinery for the new American Pulley Works, of Philadelphia, which is to manufacture a new all-sheet steel pulley, in which the hub, spokes and rims are all made of thin sheet steel.

Mr. John T. Wilson, late of Wilson, Walker & Company, of Pittsburg, Pa., and Mr. J. D. McIlvain, the well-known car builder, now of Pittsburgh, Pa., have interested themselves in the Powell Improved Furnace, with headquarters at 1204-5 Carnegie Building, Pittsburg, Pa., where they will be glad to meet all their old friends and acquaintances, and new ones, too. The Powell Furnace is adapted to metal working in all the various branches of smelting, puddling or heating.

The American Stoker Company, Dayton, O., have just secured a contract amounting to $24,000, to supply their stoker system to the two power plants of the Baltimore and Catonsville Construction Company, who will operate an electric railroad between Baltimore and Washington. The power plants are located one at Washington and the other at Baltimore, and are each of 300 horse power, requiring something like 40 of the American Stoker Company's apparatus to operate.—*Iron Age.*

The manufacturers of the Leach sanding apparatus for locomotives announce that they now have a working model, similar to those heretofore furnished air-brake instruction cars for educational purposes, which has been designed expressly to meet the demand from engineers' and firemen's clubs and lodges. These will not be given away, but will be sold at a nominal price, found necessary for their own protection. Full particulars can be obtained from Henry L. Leach, North Cambridge, Mass.

The Norfolk Creosoting Company, of Norfolk, Va., has completed a fully equipped plant, including three 100-feet cylinders, and all the labor-saving appliances for treating timber of all kinds by oil of coal tar process, with either live or superheated steam. Mr. Edmund Christian, General Manager and Engineer, gives his entire attention to the details of the work. He has had 15 years' experience in treating all kinds of timber and much of the pile work in Norfolk harbor and adjacent waters has been treated under his exclusive supervision.

Robert W. Hunt & Company, 1137 The Rookery, Chicago are inspecting the construction of 150 cars at the works of the Ensign Manufacturing Company, Huntington, W. Va., for the San Francisco & San Joaquin Valley Railway. The same firm will inspect the 600 ore cars to be built by the Pullman Company for the Duluth, Missabe & Northern Railway; 450 ore cars to be built by the Terre Haute Car and Manufacturing Company for the Duluth & Iron Range Railroad, and 400 ore, 20 flat and 4 caboose cars to be built by the Wells & French company for the Lake Superior & Ispheming Railway Company.

A suit has been entered by the Harris Car Company, of which Mr. Leslie J. Harris is President, against the American Palace Car Company and George A. Denham, Treasurer, in the United States Court of the District of Massachusetts, which involves a patent, covering the exclusive use in sleeping cars of a berth pocket beneath the floor. The Harris patent, on which the suit is based, is well known to railroad men, as a car, "Jeannette," was built in accordance with the same, and was exhibited in all parts of the United States, Canada and Mexico. It is alleged in the bill of complaint that the American Palace Car Company has constructed a car, "Boston," which is a direct infringement of the claims in the Harris patent.

The H. W. Johns Manufacturing Company, which received a gold medal—the highest award of merit—for its exhibit of asbestos manufactures at the Atlanta Exposition, has issued a neat little pamphlet containing illustrations of nine locomotives exhibited at the exposition whose boilers were lagged with the company's asbestos cement felting or fire felt lagging. The fire felt is pure asbestos made in sheets 24 by 36 inches and from ½ to 2 inches thick. The cement felting is composed of asbestos fiber, infusorial earth, and a cementing compound, forming a light porous covering that is applied by mixing with water and putting it on with a trowel, the boiler being warm at the time. Both are excellent boiler laggings.

A great many people, who saw and admired the wonderful electric lighting machines furnished by the Westinghouse Electric and Manufacturing Company to the Columbian Exposition Company for the purpose of illuminating the World's Fair, remarked at the time: "What will be done with these machines when the Fair is over." It may be interesting for these people to learn, that the Westinghouse Company recently furnished four of them to the United Electric Light and Power Company, of New York City, and they are furnishing current for lighting a considerable portion of the metropolis. Several others are installed in the plant of the Brush Electric Light Company at Baltimore, while the rest of them are distributed in several large electric light plants throughout the country.

The Davis & Egan Machine Tool Co., of Cincinnati, formerly the Lodge & Davis Machine Tool Co., controls unlimited capital and the plant which now has 60,000 square feet of floor space will be largely increased. New lines of heavy railroad tools will be added and the business promises to be one of the most extensive of the kind.

The concern manufactures tools for the production of locomotive and stationary engines, steam pumps, electric dynamos and motors, agricultural implements, sewing machines, bicycle machinery, wood-working machinery, mining machinery, etc. It has furnished the United States Government large numbers of machines for the manufacture of cannons, guns, etc., and is well represented in the Navy Yards at Washington, Norfolk, Watervliet, Brooklyn and Mare Island. It cultivates the export trade largely and has made shipments to nearly every civilized country. It has agents who travel in Mexico, South America, Russia, France and Germany. The company operates its own stores in New York, Chicago, Philadelphia, Boston and St. Louis.

The Manufacturers' Advertising Bureau, Benj. R. Western, proprietor, which has been located for a number of years at 111 Liberty street, New York City, will remove about April 15 to more commodious quarters at 126 Liberty street. This concern is widely and favorably known throughout both this country and abroad, and is unique in the business it transacts, which is unlike any other in the world, and consists in taking entire charge of the newspaper work and advertising for manufacturers who desire this very important department of their business conducted with the greatest convenience and profit. The bureau handles almost exclusively concerns who advertise in the trade journals, Mr. Western being a recognized expert in advertising media of this character, and has established a reputation for commercial integrity and scrupulous attention to the interests of its clients, of which it may well feel proud. A large number of the leading machinery concerns in the country now entrust their advertising to the care of this institution. It is because of a growing need for better facilities to transact its business that the change from 111 to 126 will be made.

It is announced that negotiations between the General Electric Company and the Westinghouse Electric & Manufacturing Company resulted last month in an arrangement with respect to a joint use of the patents of the two companies, subject to existing licenses, on terms which are considered mutually advantageous. It has been agreed that after certain exclusions the General Electric Company has contributed 62½ per cent. and the Westinghouse Electric & Manufacturing Company 37½ per cent. in value of the combined patents, and each company is licensed to use the patents of the other company except as to the matters excluded, each paying a royalty for any use of the combined patents in excess of the value of its contribution to the patents. The patents are to be managed by a board of control consisting of five members, two appointed by each company and the fifth selected by the four so appointed. Both companies have acquired during their existence a large number of valuable patents, and numerous suits have been instituted in consequence of the infringement of these patents by one party or the other or by their customers. In the prosecution of these suits large sums of money have been expended, and the general expenses of the companies have in this manner been greatly increased. It is expected that the economies to be effected will be very considerable and that the two companies and their customers will be mutually protected. The especial incentives which led to the arrangement at this time, were the recent decisions in favor of patents of the General Electric Company controlling the overhead system of electric railways, the approaching trials of a number of other important General Electric patents on controllers and details of electric railway apparatus and systems of other electrical devices, and the equally strong position of the Westinghouse Company in regard to power transmission, covered by patents of Nikola Tesla, and in view of its other patents in active litigation, some of which are of controlling importance.

New York to California.

A new line of Pullman's latest Compartment Sleeping Cars was inaugurated in January, on the Southern Railway's Piedmont Air Line Limited between New York and New Orleans, connecting with similars cars on the Southern Pacific "Sunset Limited." These cars leave New York on every Tuesday and Saturday at 4.30 p. m., connecting at New Orleans with the Pacific Coast Flyer. These cars are most elegantly furnished and have two drawing-rooms and seven state-rooms. These rooms can be used separate or thrown into a suite or private apartment. The state-rooms are unsurpassable in completeness, having private folding washstand, and all conveniences of most modern drawing-room cars.

Our Directory

OF OFFICIAL CHANGES IN MARCH.

We note the following changes of officers since our last issue. Information relative to such changes is solicited.

Atchison, Topeka & Santa Fe.—Mr. John Purcell has been appointed Assistant Master Mechanic at Argentine, Kan.

Baltimore & Ohio.—Mr. John K. Cowen, President, and Mr. Oscar G. Murray, First Vice-President, have been appointed Receivers. Robt. B. Campbell, General Manager, has resigned and is succeeded by Mr. Wm. M. Greene. Mr. Harvey Middleton has been appointed General Superintendent of Motive Power, vice Mr. G. B. Hazlehurst, resigned.

Chicago, Burlington & Quincy.—Mr. F. A. Chase is appointed Master Mechanic of the Missouri lines, with headquarters in St. Joseph. Mr. I. N. Wilbur is made Division Master Mechanic at Hannibal to succeed Mr. N. J. Paradise, deceased.

Choctaw, Oklahoma & Gulf.—Mr. Henry Wood, formerly Acting Manager, has been made General Manager, with headquarters at South McAlester, I. T.

Cincinnati, Hamilton & Dayton.—Mr. Chas. G. Waldo, formerly General Superintendent, has been appointed General Manager, vice Mr. Wm. M. Greene, resigned.

Columbus, Hocking Valley & Toledo.—Mr. W. A. Mills, heretofore Assistant to the President, has been appointed General Manager, with headquarters at Toledo, O.

Cooperstown & Charlotte.—The office of General Manager has been abolished.

Great Northern.—Mr. T. E. Adams, Master Mechanic of the Northern Division, has been appointed Superintendent of the Dakota Division, vice Mr. Russell Harding. Mr. T. E. Cramer has been appointed Master Mechanic of the Northern Division, to succeed Mr. Adams.

Indiana, Illinois & Iowa.—Peter Maher has been appointed Master Mechanic, vice L. H. Miller, resigned.

Interoceanic of Mexico.—Mr Theodore Klein will, on May 1, take the position of General Manager.

Kansas City, Pittsburgh & Gulf.—Mr. E. Dawson has been appointed General Master Mechanic, with headquarters at Pittsburgh, Kan.

Lake Shore & Michigan Southern.—Mr. W. H. Canniff, formerly General Superintendent has been appointed General Manager, Mr. P. S. Blodgett, formerly Assistant General Superintendent has been appointed General Superintendent.

Michoacan & Pacific.—The office of the General Superintendent, Mr. L. R. Gordan, removed from Maravatio to Las Trojes.

Monongahela River.—Mr. H. G. Bowles, heretofore General Manager, has been appointed General Superintendent, and Mr. J. A. Fickinger is appointed General Manager. Headquarters, Monongahela, W. Va.

Monterey, Mineral & Terminal.—Mr. M. C. Grace has resigned as Master Mechanic.

Pittsburg & Western.—Mr. Thos. M. King, Second Vice-President of the Baltimore & Ohio, has been appointed receiver by Judge Buffington, of the United States Circuit Court.

Rock Island & Peoria.—Mr. H. S. Cable has been appointed Vice-President and General Manager.

Southern.—Mr. E. L. Chapman has been appointed Assistant Superintendent of Motive Power.

Terminal Road of St. Louis.—Mr. William Taussig has resigned the Presidency and is succeeded by Mr. Julius S. Walsh, Mr. E. P. Bryan, General Manager, is made Vice-President in place of Mr. Walsh.

Texas Central.—Mr. Henry McHarg has been elected President.

West Shore.—Joseph B. Stewart has been appointed Superintendent of the Hudson River Division, Superintendent of the Walkill Valley road, and Superintendent of the Jersey Junction road, in place of William G. Wattson, deceased.